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ABSTRACT

This report describes a program for motivating students in mathematics in order to improve achievement at the high school level. The targeted population consisted of high school students in a middle class community located in a suburb of a large metropolitan area. The problems of underachievement were documented through data collected from surveys and teacher observations and grades based on test scores, homework and projects. Analysis of the probable causes literature revealed that students lose interest in mathematics. Evidence of the existence of the problem was determined through analysis of surveys, behavioral observations made by the teacher and through student grades. The literature of solution strategies was reviewed and the problem setting was analyzed. This resulted in the selection of two major categories of intervention: a modification of the curriculum to include application and real-life math problems, and a restructuring of the teachers daily lesson plans to implement a variety of teaching strategies. Post data was gathered to determine whether the intervention improved student motivation. It was discovered that the implemented strategies improved positive behaviors in the classroom. Slight improvements were also observed in student attitudes towards mathematics. Appendixes include Math Interest Survey, Math Anxiety Checklist, Sample Lesson Plans; and Sample Projects (adapted from "Hands-On Math Projects with Real-Life Applications" by Gary Robert Muschola and Judith A. Muschola). Contains 34 references, 64 figures, and 24 tables.) (Author/MM)

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IMPROVING HIGH SCHOOL STUDENTS' MATHEMATICS ACHEIVEMENT THROUGH THE USE OF MOTIVATIONAL STRATEGIES

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ABSTRACT

This report describes a program for motivating students in mathematics in order to improve achievement at the high school level. The targeted population consisted of high school students in a middle class community located in a suburb of a large metropolitan area. The problems of underachievement were documented through data collected from surveys, teacher observations and grades based on test scores, homework and projects.

Analysis of the probable causes literature revealed that students lose interest in mathematics. The researchers determined evidence of the existence of the problem through analysis of surveys, behavioral observations made by the teacher and through student grades.

The researchers reviewed the literature of solution strategies suggested by knowledgeable others combined with an analysis of the problem setting that resulted in the selection of two major categories of intervention: a modification of the curriculum to include application and real-life math problems, and a restructuring of the teachers daily lesson plans to implement a variety of teaching strategies.

The researchers gathered post data to determine whether the intervention improved student motivation. The researchers discovered that the implemented strategies improved positive behaviors in the classroom. Slight improvements were also observed in student attitudes towards mathematics.

SIGNATURE PAGE

This project was approved by

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CHAPTER 1

PROBLEM STATEMENT AND CONTEXT

General Statement of the Problem

The students of the targeted high school classes exhibit a lack of motivation that interferes with student mathematical achievement. Evidence for the existence of the problem includes teacher observations, student surveys, and analysis of student grades

Immediate Problem Context

The targeted school is a public high school consisting of 9th grade through 12th grade. This high school was built in 1950. It is a three-story building with three gymnasiums, a swimming pool and a small theater. In 1967, a tornado destroyed many parts of the building. Because of the tornado, classrooms that were built after 1967 have no windows. The school is a medium-sized high school with a student population of 1,460 and it is the only school in the district. The racial background of the school is 92.1% White, 1.3% Asian/Pacific Islander, 0.5% African American, and 0.3 % Native American. Four and two hundredths percent of the students come from low-income families. Within the student population, 0.3% have limited English proficiency. The attendance rate of this high school is 94.2% with 0.3% of the students demonstrating chronic truancy. The dropout rate for this school is 4.7% (School Report Card, 1999).

The faculty consists of 76 teachers. The gender breakdown of the faculty is 55.8% female and 44.8% male. All of the teachers at this school are White. The average teaching experience for the faculty is 18.1 years with the average teacher salary being $59,794. Seventy-nine percent of the faculty has a master's degree or beyond. The student to teacher ratio is 21.9 students to 1 teacher (School Report Card, 1999).

The targeted high school has a standard curriculum. The core subjects: math, English, science, history, and physical education are taught to the students throughout a seven period day. The class periods are 50 minutes long. Computer education, foreign language, technology preparation, and home economics are classes that must be taken to complete the graduation requirement. Students are given the opportunity to earn school credit by participating in a work study program. For students who are challenged with learning, there is a Learning Resource Program (LRP) to provide assistance. Instead of enrolling in a study hall, the students are placed in a tutorial study hall to help develop study skills.

The Mathematics program at this high school has three levels. The first level is for students who demonstrate a need for reinforcement in mathematics. Freshmen at this level begin classes in Math 1 or in Fundamentals of Algebra. The next level begins with Algebra 1. This level takes students through Algebra 1, Geometry and Advanced Algebra. For juniors and seniors who have taken Geometry but still lack the skills needed to succeed in Advanced Algebra, Transitions to College Math is available. The highest level is the honors program. This level includes Advanced Placement classes for juniors and seniors. For this research project, two classrooms will be targeted.

Classroom A

The first classroom to be studied is a Fundamentals of Algebra class. The class is composed of mostly freshmen with a few sophomores, juniors, and seniors. The class has 25 students with 13 males and 12 females. The Fundamentals of Algebra course is designed to provide extra assistance to students who need reinforcement of their math skills. This course is a pre-algebra/ pre-geometry class to prepare students for Algebra 1 the following year.

Classroom B

The second classroom is Transitions to College Math. This classroom is composed of juniors and seniors. The class has 27 students with 15 males and 12 females. The Transitions to College Math Class is designed for students who have completed Algebra and Geometry but need reinforcement of their skills before moving on to Advanced Algebra.

Community Setting

The students of the targeted high school reside in two suburban communities. The first community is a large suburb located 15 miles southwest of a major metropolitan area. The community contains mostly three and four bedroom homes. This community is an established community and is very stable. Because of this, homes are not frequently available for sale. The population of this community is 57,980. The racial make-up of this community is 96.5% White, 2.2% Hispanic, 1.2% Other, and 0.1% Black (chicagotibune.com).

The median income of this community is $69,888 with 60.2%of the population employed. The unemployment rate in this community is 2.4% and 37.4% of the population is not in the work force. The most popular occupations are managerial/professional positions and administrative support positions (chicagotribune.com).

The level of education attained by the members of the community 18 years old and over is as follows: 7.6%less than 9th grade, 12.4% 9th grade through 12th grade, 36% high school graduate, 21.6% some college, 4.8% associate's degree, 12.4% bachelor's degree, and 5.2% graduate degree (chicagotribune.com).

The second community is a small suburb located 14 miles southwest of a major metropolitan area. The community was established to provide affordable housing for returning GI's and retired veterans. Most of the living structures are duplex homes with two houses sharing a common wall. The population of this community is 4,890. The racial make-up of this community is 98.4% White, 0.9% Other, and 0.7% Hispanic (chicagotribune.com).

The median income of this community is $31,214 with 57.4% of the population employed. The unemployment rate in this community is 2.9% and 39.6% of the population is not in the work force. The most popular occupations are managerial/professional positions and administrative support positions (chicagotribune.com).

The level of education attained by members of the community 18 years and older is as follows: 5.3% less than 9th grade, 18.7% 9th grade through 12th grade, 46.1% high school graduate, 22% some college, 3.2% associate's degree, 4% bachelor's degree, and 0.7% graduate degree (chicagotribune.com).

The first community has many services to support the needs of the students at the high school. The park district of this community has many programs and facilities that the students can use. For example, there is an athletic complex that is available for the members of the community. The facility contains a track and basketball and volleyball courts. The park district also has an ice arena and numerous parks throughout the community. The community has a

large public library located within two miles of the school. The students who live in the second community can use all of the services of the first community.

National Context

Mathematics achievement is a concern in classrooms across the United States. Although test scores have improved over the past two decades, students from the United States still demonstrate less mathematical ability than other nations. "While U.S. achievement has risen across our nation, we still lag behind our international competitors. It is important that we, as a nation, take steps to improve mathematics education for grades kindergarten through 12" (Thorpe, 1999, p.1). The problem with mathematical achievement is most evident in secondary schools. Elementary school students tested above the international average and 8th grade students tested at the international average. Students who had completed high school through the 12th grade tested well below the international average (NCES, 1999). This shows a decline in the mathematical ability as the grade level increases.

Mathematical ability is important because higher-level mathematics classes are "the gateway to college, good citizenship, productive employment, and lifelong learning" (Riley, Lane, 1998, p.1). As more jobs are available in the technological field and as employers seek more qualified employees, students' mathematical abilities need to improve.

Attitudes held by the students about mathematics can affect their achievement. One of these attitudes can be described as math anxiety. Mathematics anxiety is fear and helplessness encountered when solving mathematical problems. This type of anxiety can cause students to refuse to learn about mathematics or put the students in a position where they cannot learn about mathematics (Godbey, 1997). Students also do not place a high value on the mathematics education that they can receive.

Lack of student motivation can also hinder mathematical achievement. "The National Council of Teachers of Mathematics (NCTM) 'Standards' stresses motivation as a goal of reform-minded mathematics. Teachers therefore need to be attentive to student motivation" (Givvin, 1996, p. 2). By the time students reach high school, their attitudes towards mathematics has significantly decreased (Joannon-Bellows, 1999). An increase in student motivation can lead to an increase in mathematical ability. It is important that teachers are aware of how students' attitudes can affect their achievement.

CHAPTER 2

PROBLEM DOCUMENTATION

Problem Evidence

In order to determine the current level of motivation for the class, student surveys and observation checklists were created. Semester grades and homework grades were also analyzed. In classroom A, there were 28 students in the class, and 25 were involved in this process. In classroom B, there were 26 students in the class and 24 participated in the process.

The teacher researcher developed a student survey to record the current interest level in mathematics (Appendix A). A summary of the results for teacher A is shown in Table 1.

Table 1
Number of Responses for the Math Interest Survey for Teacher A

Question	*Strongly agree*	*Agree*	*Not sure*	*Disagree*	*Strongly Disagree*
Do you find math interesting	4	6	4	10	1
Do you find math challenging	5	13	2	4	1
Do you think you will use math in the future	6	8	8	1	1
Do you use math in your every day life	8	10	4	2	1
Does math relate to your life	3	7	7	4	4

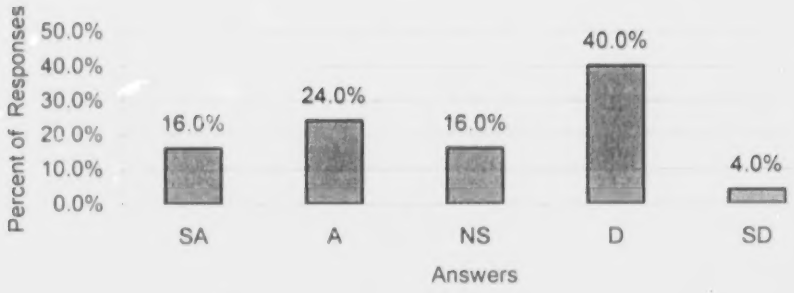

Figure 1. Responses to Question 1: "Do you find math interesting?"

When asked if they found math interesting, two-fifths of the 25 students responded that they do find math interesting. However, slightly more than two-fifths of the students responded that they did not find math interesting. With almost one-fifth of the students responding that they were unsure of their math interest, this suggests that teachers need to do more to help build student interest in math.

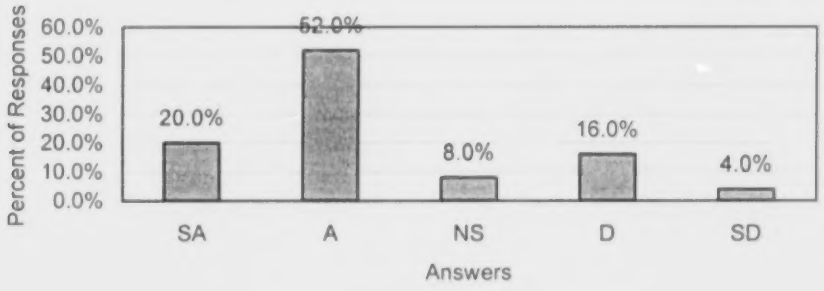

Figure 2. Responses to Question 2: "Do you find math challenging?"

Nearly three-fourths of the students out of 25 surveyed find math challenging. Only one-fifth of the students responded that they felt that math was not challenging. This data suggests that student interest towards math may be influenced by the difficulty the students' experience.

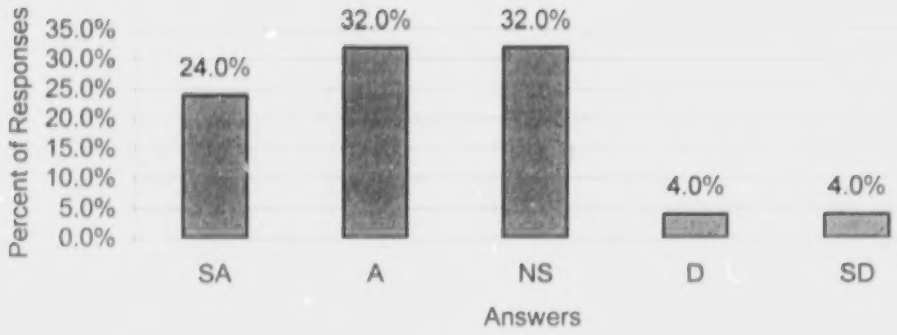

Figure 3. Responses to Question 3: "Do you use math in your every day life?"

More than half of the 25 students surveyed responded that they use math in their every day life. This suggests that the teacher provides enough real world examples to help students relate math to their lives. The teacher researchers are concerned that one-third of the students responded that they were unsure whether math relates to their lives. The teacher researchers feel that more examples and more explanation can help these students realize how much math is a part of their lives.

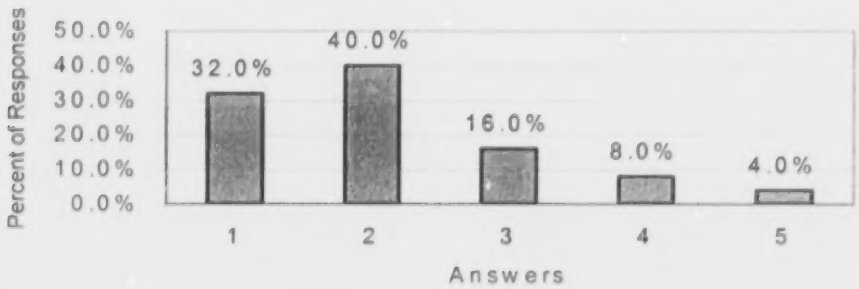

Figure 4. Responses to Question 4: "Do you think you will use math in your future?"

Almost three-fourths of the 25 students surveyed responded that they thought they would use math in the future. Again, this suggests that the teacher is teaching lessons that incorporate the importance of math. The teacher should continue the emphasis that is placed on using math in the future.

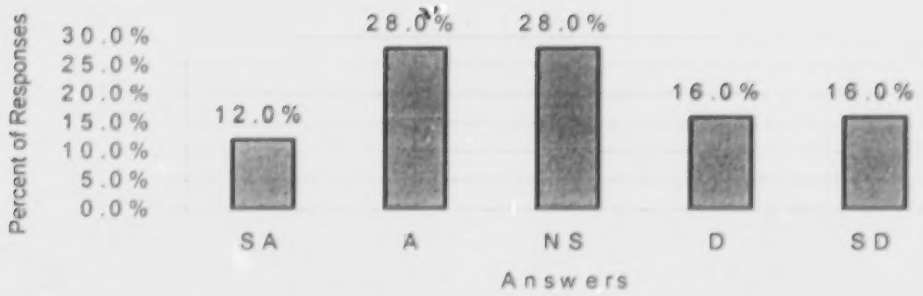

Figure 5. Responses to Question 5: "Does math relate to your life?"

Two-fifths of the 25 students surveyed responded that math did relate to their lives. More than one-third of the students said that math did not relate and a little less than one-third said that they were unsure whether math related to their lives. This indicates that the teacher should take steps to ensure all students feel that math relates to their lives. This could be accomplished through whole class activities and on an individual basis with the teacher and student.

Table 2
The Number of Responses for the Math Interest Survey for Teacher B

Question	*Strongly agree*	*Agree*	*Not sure*	*Disagree*	*Strongly disagree*
Do you find math interesting	0	7	8	4	4
Do you find math challenging	2	14	3	1	3
Do you think you will use math in the future	8	12	2	0	1
Do you use math in your every day life	5	13	3	2	0
Does math relate to your life	2	10	6	3	2

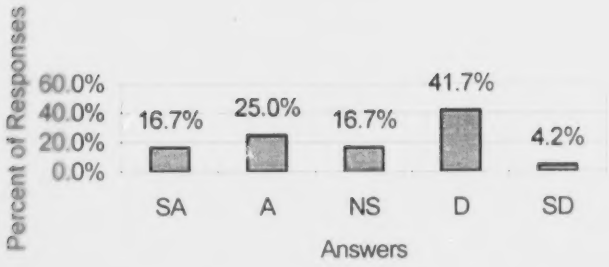

Figure 6. Responses to Question 1: "Do you find math interesting?"

Out of the 23 students surveyed, a little less than half of the students responded that they did not find math interesting. Approximately two-fifths of the students responded that they did find math interesting. This suggests that the teacher should plan lessons that are more interesting to help build student interest in math. The teacher could ask students for input to help make the class more interesting.

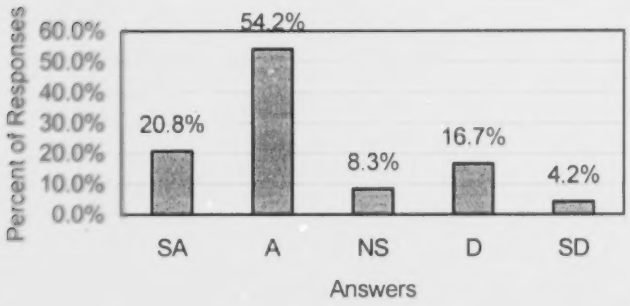

Figure 7. Responses to Question 2: "Do you find math challenging?"

Three-fourths of the 23 students surveyed responded that they find math challenging. The students surveyed are enrolled in a math class that prepares them for Algebra 1. The course reviews topics that are needed for the students to be successful in Algebra 1. This data suggests that more steps could be taken in the classroom to help ease the difficulty the students feel. The difficulty the students experience could be the cause of the lack of interest in math.

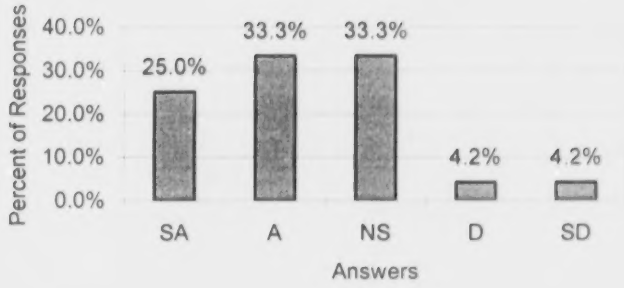

Figure 8. Responses to Question 3: "Do you use math in your every day life?"

More than half of the 23 students surveyed responded that they used math every day. The results for Teacher B are similar to the results for Teacher A in that one-third of the students responded that they were unsure if they used math every day. Again, incorporating more real world examples and better explanations of these examples can help the students see how they use math every day.

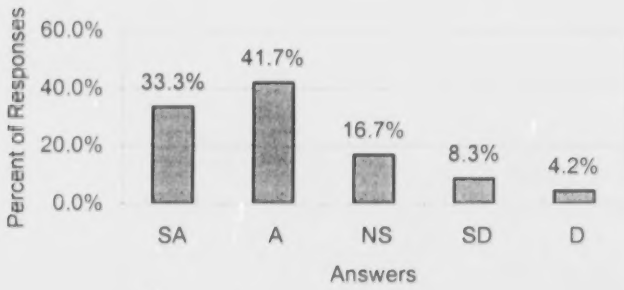

Figure 9. Responses to Question 4: "Does math relate to your life?"

Three-fourths of the students responded that math relates to their lives. This suggests that the teacher is helping a majority of the students see the relevance of math. To encourage the other quarter of the class that disagreed or were unsure, the teacher could teach lessons that help all of the students see how math relates to their lives.

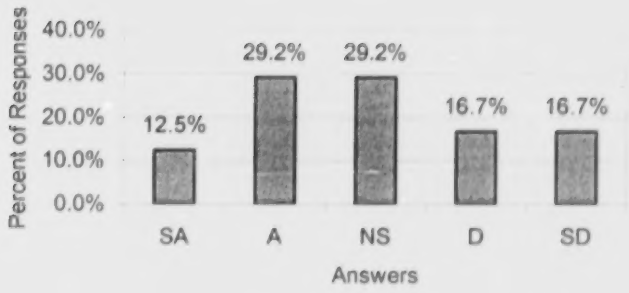

Figure 10. Responses to Question 5: "Do you think you will use math in the future?"

More than two-fifths of the 23 students surveyed responded that they thought they would use math in the future. The teacher researchers are concerned that almost two-thirds of the students disagreed or are unsure of whether or not they will use math in the future. The teacher researchers feel that they should incorporate the importance of math and the ways that students will sue math into their daily lessons.

The teacher researchers also developed a survey to record math anxiety. (Appendix B) The results of the survey are shown below.

Table 3
Number of Responses for the Math Anxiety Survey for Teacher A

Question	*Strongly agree*	*Agree*	*Not Sure*	*Disagree*	*Strongly disagree*
I would not like to take more math classes	10	3	5	2	5
I worry about my ability to solve math problems	6	9	3	6	1
I get uptight during math test	7	4	8	4	2
I get a sinking feeling when I try to do math problems	5	3	6	7	4
My mind goes blank and I am unable to think clearly when doing my math	4	6	5	7	3
Mathematics makes me feel uncomfortable and nervous	4	5	5	5	6
Mathematics makes me feel uneasy and confused	5	7	3	7	3

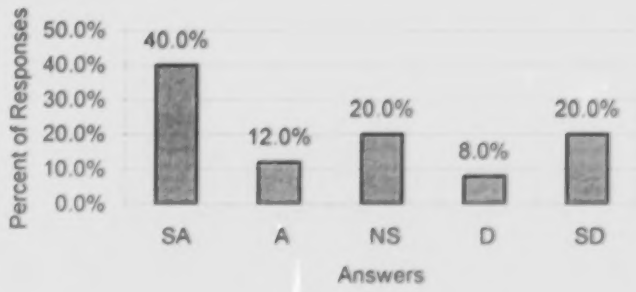

Figure 11. Responses to Question 1: "I would not like to take more math classes"

More than half of the 25 students surveyed responded that they would not like to take more math classes. One-fifth of the students responded that they were unsure whether they would take more math classes. The teacher researchers feel that this number is high because many students may have been confused with the wording of the question.

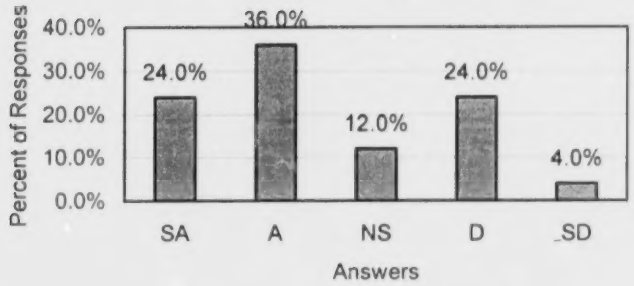

Figure 12. Responses to Question 2: "I worry about my ability to solve math problems"

Almost two-thirds of the 25 students surveyed responded that they worry about their ability to solve math problems. This data suggests that the teacher should help the students feel more comfortable solving problems. The teacher could provide strategies to help the students solve problems. This may alleviate any stress that the students feel.

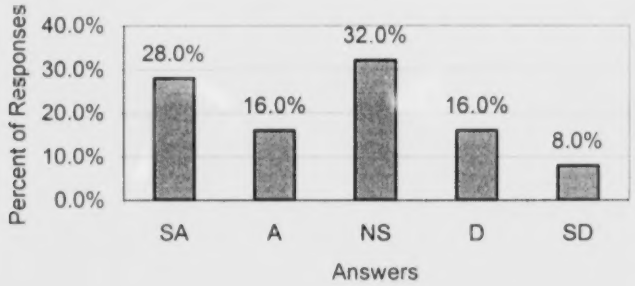

Figure 13. Responses to Question 3: "I get uptight during math tests"

More than two-fifths of the students surveyed said that they feel uptight during math tests. One-third of the 25 students surveyed were unsure of their feelings during tests. Students may choose to not continue their math education because of these feelings.

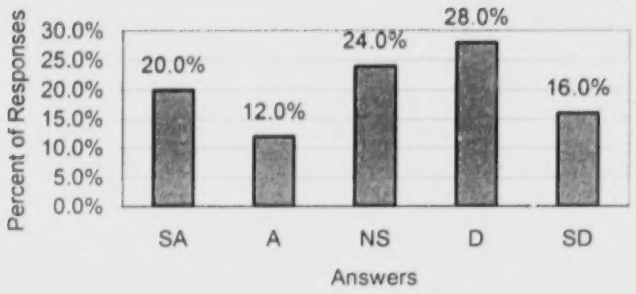

Figure 14. Responses to Question 4: "I get a sinking feeling when I try to do math problems"

Overall, more students disagreed when asked if they got a sinking feeling when doing math problems. More than two-fifths of the 25 students surveyed disagreed with the statement. Students who are not interested in math or have been discouraged for a long time with math, may not care about completing math problems. This may be one of the reasons for the high percentage of students who disagreed.

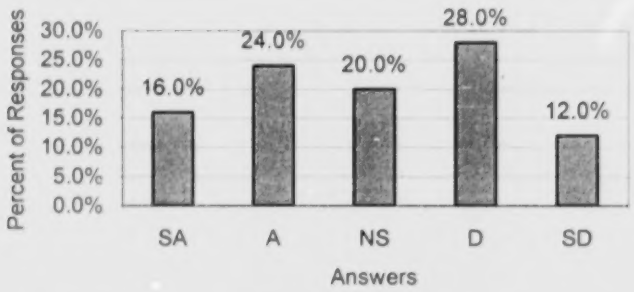

Figure 15. Responses to Question 5: "My mind goes blank and I am unable to think clearly when doing my math"

Out of the 25 students surveyed, an equal amount of students agreed and disagreed with the statement that their mind goes blank when doing math problems. The teacher researchers have found that this is a common fear among high school students. The teacher researchers are

interested to see if the intervention helps the students remember the material while doing math problems.

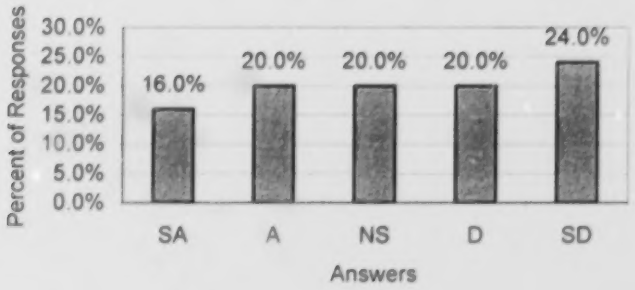

Figure 16. Responses to Question 6: "Mathematics makes me feel uncomfortable and nervous"

Almost half of the students surveyed responded that math makes them feel uncomfortable and nervous. This concerns the teacher researchers because students are not able to perform to the best of their ability when they are nervous.

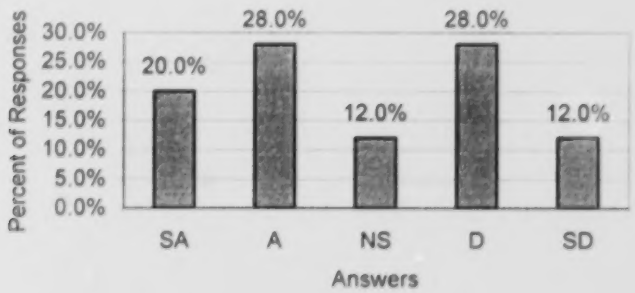

Figure 17. Responses to Question 7: "Mathematics makes me feel uneasy and confused"

Nearly half of students surveyed responded that math makes them feel uneasy and confused. This is not surprising when compared to the responses to the previous questions.

Table 4
The Number of Responses the Math Anxiety Survey for Teacher B

Question	*Strongly agree*	*Agree*	*Not sure*	*Disagree*	*Strongly disagree*
I would not like to take more math classes	5	1	8	6	4
I worry about my ability to solve math problems	3	9	4	2	6
I get uptight during math test	6	5	1	7	5
I get a sinking feeling when I try to do math problems	4	2	3	9	6
My mind goes blank and I am unable to think clearly when doing my math	5	3	1	9	6
Mathematics makes me feel uncomfortable and nervous	3	0	6	8	7
Mathematics makes me feel uneasy and confused	4	0	5	8	7

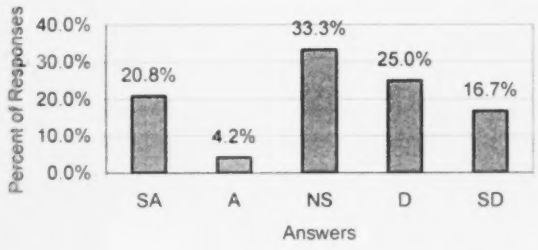

Figure 18. Responses to Question 1: "I would not like to take more math classes"

The responses to the question "I would not like to take more math classes" were quite different for Teacher B than for Teacher A. Of the 24 students surveyed, one-fourth responded that they wanted to end their math education. Three-fourths of the students either disagreed or

were unsure. Again, results for this question may not be accurate because the wording of the question was confusing.

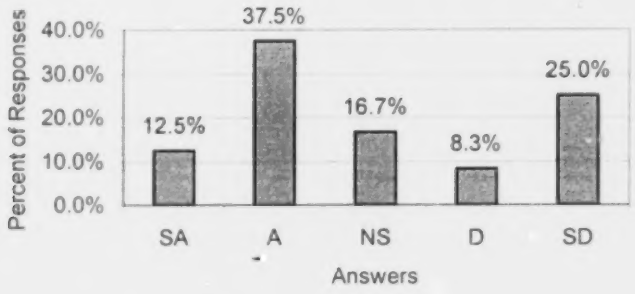

Figure 19. Responses to Question 2: "I worry about my ability to solve math problems"

Of the 24 students surveyed, half of the students agreed that they worry when solving math problems. The teacher needs to be aware of this and the teacher needs to make sure that the students are given a chance to share their worries. Working together as a class may help alleviate some of the students' worries.

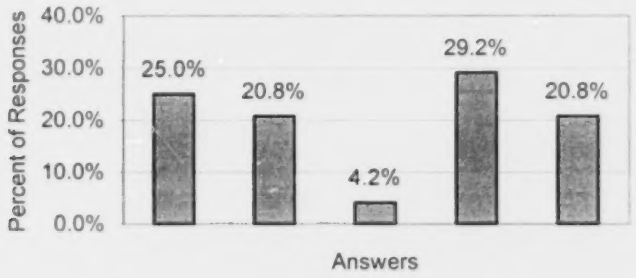

Figure 20. Responses to Question 3: "I get uptight during math tests"

The responses to this question were almost equally distributed between those students who agreed and those who disagreed. The students who agreed may be the same students who worry about their math ability. The teacher should prepare the students well for each test to help the students relax so they can concentrate on the material.

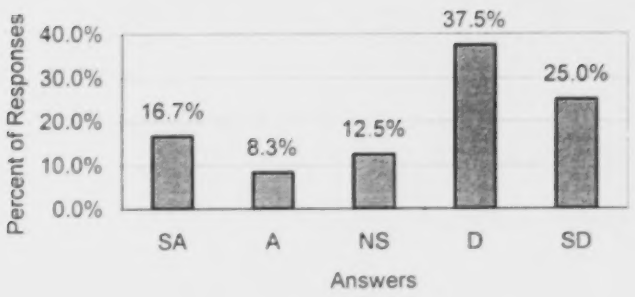

Figure 21. Responses to Question 4: "I get a sinking feeling when I try to do math problems"

Out of the 24 students who responded, almost two-thirds of the students disagreed when asked this question. This is good because most students give up when they feel like they are struggling. These students work hard and will not give up on math problems.

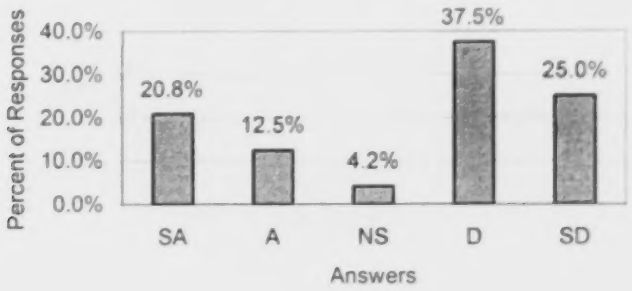

Figure 22. Responses to Question 5: "My mind goes blank and I am unable to think clearly when doing my math"

Nearly two-thirds of the 24 students surveyed responded that their mind does not go blank when completing math problems. While this is a high number of students who feel comfortable doing their math, almost one-third of the students responded that their mind does go blank. The teacher needs to help these students think clearly when working on an assignment. The teacher could pair up students who can think clearly with those that cannot. The students may be able to learn from one another.

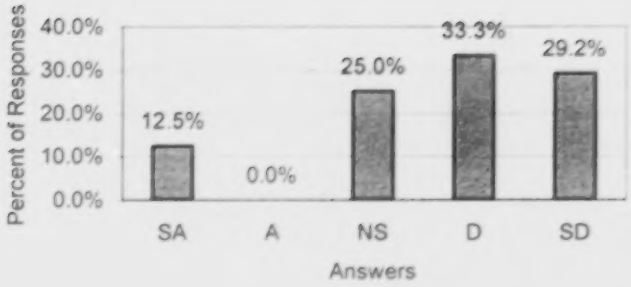

Figure 23. Responses to Question 6: "Mathematics makes me feel uncomfortable and nervous"

Out of the 24 students surveyed, three-fifths of the students responded that they do not feel nervous when doing math problems. This is encouraging data. The students feel comfortable with their math ability. The concern that the teacher researchers have is that a quarter of the students are unsure whether they are nervous when doing math problems. The teacher needs to help those students feel at ease with their math ability.

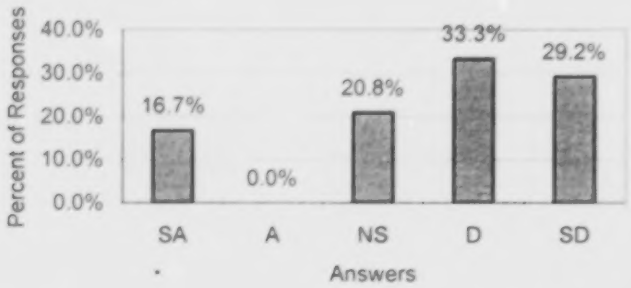

Figure 24. Responses to Question 7: "Mathematics makes me feel uneasy and confused"

The results for question 7 were similar to the results for question 6. Three-fifths of the students disagreed with the statement asking them whether math makes them confused. Again, the data that has the teacher researchers concerned is that one-fifth of the students are unsure about how math makes them feel.

The teacher researchers observed the students for a period of two weeks (appendix 3). Students were observed for 10 class periods. The teacher researchers observed both positive and negative behaviors. The following is a list of the behaviors.

Table 5
Number of Occurrences for Negative Behaviors for Teacher A

Behavior	*Number of times*
Side Bar Conversations	35
Day Dreaming	13
Working on other subjects	15

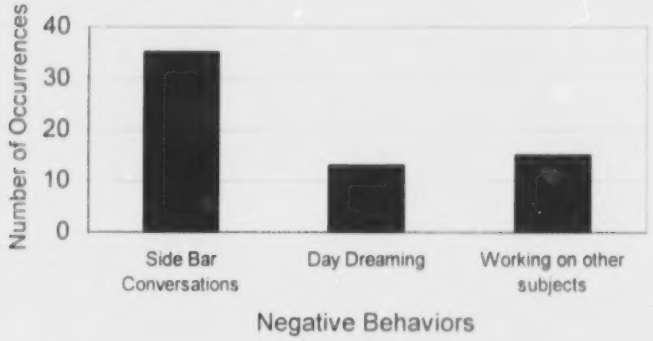

Figure 25. The Number of Occurrences of Negative Behaviors for Teacher A

The data indicates that on average, three students per class were observed conducting sidebar conversations. About one student per class period was observed day dreaming while one or two students per class period were observed doing work for other classes.

Table 6
The Number of Occurrences for Positive Behaviors

Behavior	*Number of times*
Ask for help	12
Seek outside tutoring	3
Making up missed assignments	5

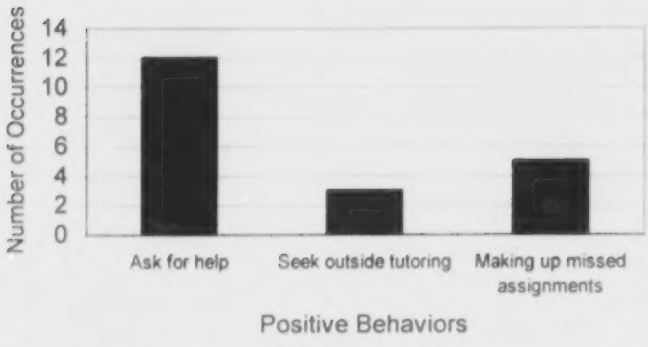

Figure 26. The Number of Occurrences of Positive Behaviors for Teacher A

The data indicates that one student per class period asked for help with their assignments. Only three students came in for extra help during the two-week period while five students made up missing assignments. In comparing the positive and negative behaviors, it is obvious that in this classroom, the negative behaviors were observed more than the positive behaviors.

Table 7
The Number of Occurrences for Negative Behaviors for Teacher B

Behavior	*Number of times*
Side Bar Conversations	10
Day Dreaming	27
Working on other subjects	4

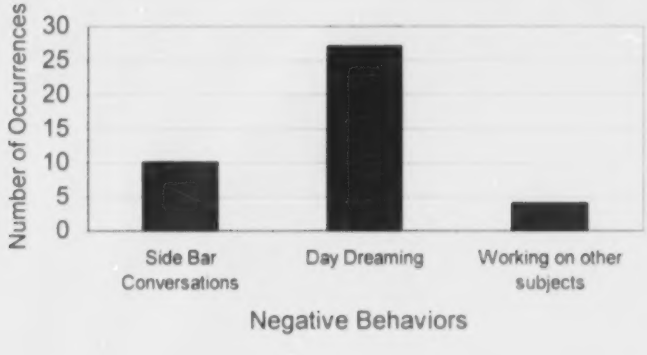

Figure 27. The Number of Occurrences of Negative Behaviors for Teacher B

The data indicates that on average, one student per class period was observed conducting a side bar conversation. Almost three students per class were observed day dreaming. Only four students in the two week period were observed working on other subjects.

Table 8
The Number of Occurrences for Positive Behaviors for Teacher B

Behavior	*Number of times*
Ask for help	1
Seek outside tutoring	7
Making up missed assignments	3

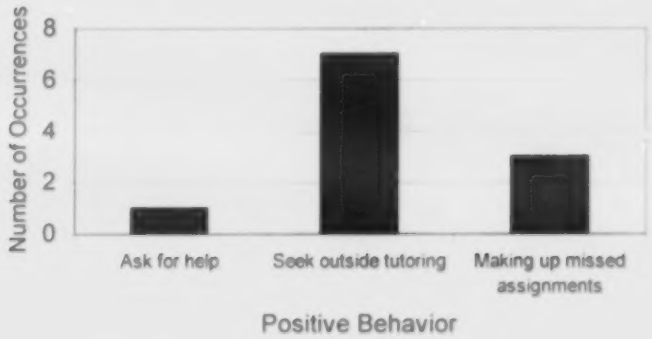

Figure 28. The Number of Occurrences of Positive Behaviors for Teacher B

During the two-week period, only one student was observed asking for help from the teacher during class time. However, seven students were observed coming in to school early or staying late for extra help. Only three students in the two-week period made up missing assignments.

Finally the teacher researchers analyzed the student's grades. They first analyzed the students overall grades. Then they looked at homework grades. Homework grades account for 25% of the final grade.

Table 9
Semester Grades for Teacher A

Grade	*Number of students with this grade*
A	2
B	7
C	4
D	5
F	7

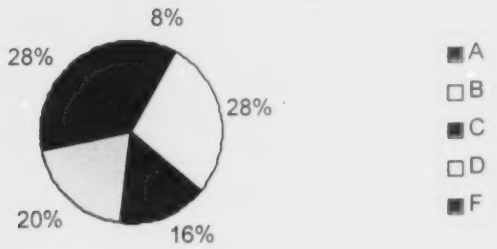

Figure 29: Semester Grades for Teacher A

Table 10
Homework Grades for Teacher A

Grade	*Number of students with this grade*
A	7
B	2
C	3
D	3
F	10

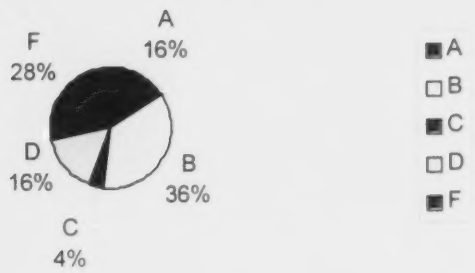

Figure 30. Homework Grades for Teacher A

Table 11
Semester Grades for Teacher B

Grade	*Number of students with this grade*
A	4
B	9
C	1
D	4
F	6

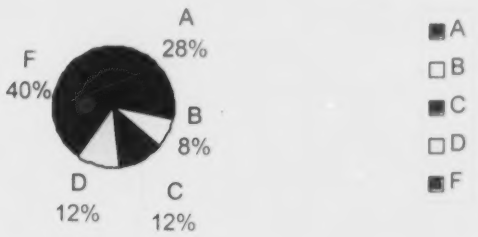

Figure 31. Semester Grades for Teacher B

Table 12
Homework Grades for Teacher B

Grade	*Number of students with this grade*
A	11
B	5
C	1
D	0
F	7

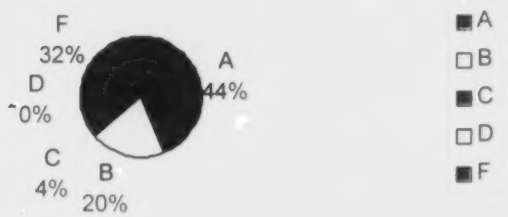

Figure 32: Homework Grades for Teacher B

In looking at the students' grades in Teacher A and Teacher B's classroom, it is obvious that there is room for improvement. In Teacher A's classroom, only 8% of the students received an A in the class while 28% of the students received a failing grade. The high number of failing students could be due to the lack of homework completed. 40% of the students received a failing grade in the homework portion of their semester grade.

In Teacher B's classroom, 17% of the students received an A in the class, while 25% of the students failed. Although the number of students receiving A's is higher, the number of failing students is still too low. The poor grades may be due to low homework grades. 29% of the students had failing homework grades. However, 46% of the students had A's for their homework grade. This could happen for two reasons. One reason is that the teacher may grade homework differently than Teacher A. The second reason is that the students may be more responsible and turn in their homework assignments.

Probable Causes

The literature suggests that there are many underlying factors that can inhibit students' motivation in mathematics. Teacher attitudes, student attitudes and curriculum deficiencies all contribute to low achievement among students. Following is a discussion concerning the targeted probable causes.

Teacher Attitudes

Habits formed by teachers can have an adverse affect on the learning environment in the classroom. Teachers who hold low expectations for their students can influence the students' motivation level. " Students tend to internalize the beliefs teachers have about their ability. Generally, they 'rise or fall to the level of expectation of their teachers… When teachers believe in students, students believe in themselves. When those you respect think you can, *you* think you can [emphasis in original]'" (Raffini cited in Lumsden, 1997, p.4). Teachers tend to treat

students who have been classified as having a low ability level differently than other students. These students are not given the opportunity to answer questions in class, receive the praise and feedback that other students receive or participate in challenging activities (Lumsden, 1997, p.4).

In the classroom, emphasis is placed on evaluation rather than understanding. Students, who are placed in lower level classes, tend to receive instruction that is based on memorization of facts. Teachers do not give these students the opportunity to truly understand the concepts being presented. The students are tested on rote facts rather than on analysis of those facts. The students ultimately receive an education that has been watered down (Lumsden, 1994, p.1).

Another factor that affects student motivation is caused by how teachers present new material. Math concepts can be very challenging to students who are not able to understand the abstract nature of the subject. Teachers do not realize that the students are struggling and blame the students when they cannot follow a discussion of the material. Teachers do not integrate new strategies into their lessons to help students understand. The way that the teacher learned the material is how it is presented even if there are new ways to introduce the concepts (Godbey, 1997, p.8).

Lessons created by teachers do not incorporate all of the ways in which students learn. Students learn the most when new material is presented using more than one method. More than one of the multiple intelligences should be included in order to maximize the learning potential for all students. Also, teachers who are not involved in the students' learning can negatively affect motivation. "Low-involvement teachers seemed to use right answers as the means to reach goals of completion or grades, assuming that math was something to 'get done'" (Turner, Meyer, Cox, Logan, DiCintio, & Thomas, 1998, p.743). When the teachers are not interested in finding out how and why, the students will not be interested.

When a student does not feel that math is interesting, his or her motivation level decreases. Many teachers who follow a lecture format in the classroom lose student interest because the students are not interested in listening to the teacher talk. The student skill level could be high, because the teacher is repeating problems and how to solve the problems. However, because the student does not feel challenged, his or her interest is low and it subsequently leads to boredom (Turner, Meyer, Cox, Logan, DiCintio, & Thomas, 1998, p.733).

Also, research has found that teachers teach math the way that they learned math in high school. The National Council for the Teachers of Mathematics has made recommendations to change the mathematics curriculum to help all students. When teachers teach the way that they were taught, it does not allow for change in the motivation of students (Hiebert, 1999, p. 11).

Student attitudes

The teacher researchers have found that student behavior and attitudes can also affect student motivation in mathematics. Because mathematical concepts build on each other, it is important for students to understand each concept that is being presented. Missing one key concept can cause the student to struggle through the rest of their mathematics education. Students miss concepts in two ways: school absences or not understanding a concept that was presented and not asking questions to help clarify.

"Parents perpetuating the myth that mathematical ability is inborn or hereditary may also be a contributing factor to math anxiety" (Godbey, 1997, p.5). Students who feel anxious in math class are not going to be motivated to learn. Parent attitudes can affect students. Many parents did not perform well in math, so they do not expect their child to perform well. Parents believe that either a student understands math or they do not understand math. If the parent believes that the student does not have a mathematical mind, they accept the student's poor grade

in math. What the parent fails to realize is that math is not based on ability. Achievement in mathematics is due to hard work.

Students who have low self-esteem often have low motivation to succeed in mathematics. These students are not confident in their mathematics ability. "Repeated low grades, placement in lower level groups, and low expectations can all lead to a decrease in confidence" (Alford, 1997, p.65). Students do not want to ask questions to understand the material better because they are afraid of what their peers will think about them. They do not want to appear stupid in front of the teacher or their classmates. A study conducted by Ryan and Pintrich (1997) illustrates that there are two ways in which high school students react to asking for help when they need it. The first method occurs when the student avoids help even when it is needed. The student either skips the problem that is confusing or writes down any answer. The second method is adaptive help seeking. The student asks questions that provide hints to solve the problem or asks for an example that is similar to the problem that needs to be solved.

Anxiety in math class can be caused by a bad experience with a previous math teacher (Godbey, 1997, p.5). "Teachers play a very important role in the students' learning of mathematics and attitudes toward mathematics" (Dossey cited in Tapia, 1996, p.5). Research has shown that teacher attitudes affect student attitudes more than student achievement. Students have more success in math classes if they have had 3 years of math with teachers who have positive attitudes (Tapia, 1996, p.6).

Problems with the mathematics curriculum

The curriculum in mathematics classes seems irrelevant to most students. They do not see the need for math in their lives. Most high school students are dealing with relationship and

identity issues. When teachers do not relate topics to issues that adolescents are struggling with, the students become less interested (Strong, Silver, & Robinson, 1995, p.4).

Traditional mathematics programs emphasize computation rather than understanding of topics. Students are not given the opportunity to understand concepts or connect concepts to previous knowledge. Also, the work that students produce is based on one way that they have learned how to solve the problems. Teachers are not giving students the opportunity to find other methods to solve problems (Hiebert, 1999, p. 11).

The United States mathematics curriculum, when compared to other countries, relies heavily on definitions and calculations. "Compared with the curricula in other countries, the U.S. curriculum provides few opportunities for students to solve challenging problems and to engage in mathematical reasoning, communicating, conjecturing, justifying and proving" (Hiebert, 1999, p. 11). Hiebert also said that the U.S. curriculum is repetitive, unfocused, and undemanding (1999, p. 11).

Another problem with curriculum is how the curriculum is presented. All students have different methods for learning. When a teacher teaches the material in one manner and that manner conflicts with the students learning style, the student does not learn the material.

"If we require students to receive information in a way which does not correspond with their personal dominant learning modes, to perform under conditions which interfere with their learning, or to demonstrate their learning in a manner which does not allow them to use their strengths, artificial stress is created, motivation is reduced and performance results are depressed" (Green, 1999, p. 3).

Textbooks are detrimental to the mathematics curriculum because they do not let students practice the skills they need and the problems do not reflect real-life situations. Students should

be taught to understand concepts. "Getting a collection of isolated concepts in a youngster's head does not guarantee that these ideas will be organized and related to one another in a useful way" (Lesh, 1985, p. 439).

Finally, within the mathematics curriculum, teachers have a hard time finding strategies to effectively teach their students. "It is hard to design thinking activities that captivate students on an ongoing basis" (Pogrow, 1998, p. 118).

CHAPTER 3

THE SOLUTION STRATEGY

Literature Review

Students today need a stimulus to motivate them to do mathematics. The review of the literature suggests that both the teacher and the curriculum play an important role in the motivation of students. According to Given, "The results suggest that students with maladaptive motivational orientations can be helped by adjustments in the nature of instruction and evaluation" (1996, p. 4).

Instructional strategies

The instructional strategies teachers use refers to the day-to-day activities that take place in their classrooms. It is essential that teachers include a variety of instructional strategies to foster enthusiasm in students (Turner, Meyer, Cox, Logan, Dicintio & Thomas, 1998). This also prevents students from becoming bored from the use of repetitious teaching patterns. Teachers need to be aware that students learn in many different manners. Using a variety of techniques allows teachers to reach all students regardless of their learning styles. According to Green,

> There is much evidence that individuals do not all learn in the same way. If we require students to receive information in a way that dos not correspond with their personal dominant learning modes, to perform under conditions which interfere

> with their learning, or to demonstrate their learning in a manner which does not allow them to use their strengths, artificial stress is created, motivation is reduced and performance results are depressed. (1999, p.2)

Cooperative Learning

Cooperative learning is a type of instructional technique that allows students to work with one or more individuals. This provides children the opportunity to learn in a social situation by interacting with their classmates. Students are often motivated to contribute to the group activity by indirect pressure from their peers. By working with and teaching each other, children are given multiple approaches to solving a problem (Campbell & Storo, 1996). Finally, students can use cooperative learning to work together and form lasting study groups (Alford, 1997).

Hands-on learning

Hands-on learning is a teaching method that involves using manipulatives. It is an instructional technique that has been proven to be effective in the classroom (Middleton, 1995). It provides pupils a different way of looking at material and gives them an opportunity to learn kinesthetically. According to Godbey, "Manipulatives can sometimes open the eyes of a student to math concepts previously not understood because of that student's learning style" (1997, p. 7). Manipulatives can also involve various forms of technology. In mathematics, the use of the graphing calculator has been shown to improve motivation (Alford, 1997). Finally, students tend to enjoy hands-on learning because they are able to be actively involved in solving various problems.

Problem based learning

Another instructional technique that can improve motivation is inquiry-based learning. This is based on the premise that people are naturally curious (Ediger, 1998). Students are given the problem first and then must find ways to solve it. This allows pupils to see there are different methods to solve each problem and gives them an opportunity to see how mathematics is applied to real-life situations. Problem based learning gives the students an opportunity to use higher order thinking skills.

> .If we acquire information within a problem based mode then it will be more easily available for transfer when we want it. This makes sense, because within such a context we are using information constructively – generalizing and analyzing opinions, making decisions, reflecting – not merely taking it in and passing it back verbatim (Barrell, 1992, p. 264)

Student centered instruction

In general instructional strategies need to move from being teacher centered to student centered. In student- centered instruction, children bear the burden of responsibility for their learning (Turner, Meyer, Cox, Logan, Dicintio & Thomas, 1998). Students are more engaged in the learning process because they must come up with the solutions on their own (Laveault, LeBlanc, Leroux, 1999). Teachers can also provide opportunities for the students to be creative by encouraging them to come up with their individual strategies to solve problems and then asking them to share these strategies with the class (Malloy & Malloy, 1998).

Teacher attitude

Another component of motivation is the teachers' attitude regarding their class. Teachers need to have a positive attitude towards the subject that they are teaching because the

instructors' attitude often rubs off on the students. According to Tapia, "Research has also shown the effect of teacher attitude toward mathematics on student attitude and achievement in mathematics. Analysis of the data indicated that teacher attitude was significantly related to student attitude" (1996, p. 6). Instructors must have high standards for their students. (Turner, Meyer, Cox, Logan, Dicintio & Thomas, 1998). This is because students naturally rise to the level of expectations of their instructor. According to Lumsden, "When teachers and administrators maintain high expectations, they encourage in students a desire to aim high rather than to slide by. To expect less is to do students a disservice, not a favor" (1997, p.3). Also, When instructors expect more from students they often cover more material and require that their students participate and respond more in class. (Tauber, 1998) Finally, enthusiasm is crucial for teachers. It conveys a positive message and tends to be contagious in the classroom (Godbey, 1997).

Motivation has been shown to be affected by self -esteem. Students with high self-esteem are usually more motivated than students with low self –esteem (Turner, Meyer, Cox, Logan, Dicintio & Thomas, 1998). Teachers need to improve students' self-confidence and reduce their math anxiety. Instructors may do this by having a sincere and caring attitude. (Godbey, 1997). Teachers can also provide their students with positive feedback. According to Rigby, Deci, Patrick and Ryan, "Other studies have shown that positive feedback tends to strengthen perceived competence and enhance intrinsic motivation" (1992, p. 175). Positive feedback allows students to build on their prior successes. Children also benefit from verbal praise for the work they have accomplished. (Ediger, 1998) Finally, students should be encouraged to be original and demonstrate their self-expression. Teachers can promote these qualities by connecting projects to the students' thoughts and ideas, and by allowing students to

have a choice in the projects or presentations that they are assigned. (Strong, Silver & Robinson, 1995)

Classroom atmosphere

The classroom atmosphere is important for students to become motivated. Use of humor is an effective tool to help relieve math anxiety and make children more comfortable. As Godbey says, "Introducing humor into the classroom can be extremely advantageous to the learning of mathematics." (Godbey, 1997, p. 8). Teachers need to make their classroom a safe place for learning so students feel secure with their environment and their ability to participate in the class. "If students experience the classroom as a caring, supportive place where there is a sense of belonging and everyone is valued and respected, they will tend to participate more fully in the process of learning" (Lumsden, 1994, p. 3). Finally, the classroom environment should be one that fosters involvement. This causes the students to be actively engaged in the education process.

The last thing teachers can do is improve their day-to-day activities to help motivate the students. In order to make the students excited for learning teachers should begin each class with an energizing anticipatory set. Instructors can give their students reinforcement for what they have learned by reviewing old ideas and previewing new ideas. Further, instructors must provide students with the criteria for success so they are aware of what they need to do to accomplish their goals (Alford, 1997).

Assessment

Teachers need to make sure they are assessing the students in a method that is authentic for the student. Instructors should test the students in a method that is similar to the ways students have learned. (Sparapani, 1998). There are many forms of alternative assessment that

can test the thinking and learning of students. A National Summit on Mathematical Assessment was held in 1991. They concluded that assessment should be primarily used to improve the learning and instruction of students. They also determined several goals for assessment including aligning the assessments with the curriculum, using a variety of assessment techniques and developing guidelines for "judging the quality of all forms of mathematics assessments" (Bronson & Hartog, 1993, p. 3).

Curriculum

Student motivation is not only improved by the teachers but also by the curriculum. In order for students to be enthusiastic about mathematics it must be interesting to them. In a study done in 1995, Schiefele and Csikszentmihalyi found that "the quality of experience when doing mathematics was mainly related to interest" (Schiefele & Csikszentmihalyi, 1995). Interest can be cultivated by relating the material to their lives. Students also need to see how the material they are currently learning will be relevant to their future. The curriculum should be useful and useable so students are reassured that what they are learning is purposeful (Godbey, 1997). This can be accomplished by giving the children practical applications for using the information they have learned. In a study done in 1995, Middleton found that using real-life applications made mathematics more "fun" (Middleton, 1995).

Finally the curriculum needs to be at the appropriate level for the student. The material should be challenging enough to keep students interested. According to Turner, Meyer, Cox, Logan DiCintio and Thomas, "Students in high involvement classrooms reported challenges and skills as above average and matched, students in low involvement classrooms reported skills as exceeding challenges" (Turner, Meyer, Cox, Logan, DiCintio and Thomas, 1998, p. 730). The

curriculum can be made more challenging by incorporating higher order thinking skills into the program.

In order to enhance the curriculum, teachers need to develop personal learning strategies for each student. Teachers should include social and emotional skill building into their lessons. By doing this, students will connect emotions with concepts they have learned. This will help them to apply skills in the future. Teachers can do this by "placing students in small groups and assigning problems that are open-ended, challenging, and related to the real world" (Green, 1999, p.3). Administrators should give teachers opportunities for staff development to make learning personal for each student. Teachers need to have time to plan complex lessons, share ideas and reflect on the curriculum.

In conclusion, student motivation can be improved by changes made to the curriculum and to the teacher. The instructor needs to have a variety of instructional strategies. The teacher should also create a positive classroom atmosphere and environment. Finally, the curriculum needs to be interesting and challenging.

In order to improve student motivation, the teacher researchers have developed the following project objectives.

Project Objectives

As a result of curriculum modifications during the period of January 2001 to May 2001, the targeted high school classes will increase their engagement in mathematics as measured by teacher observation and student surveys.

As a result of increased instructional techniques during the period of January 2001 to May 2001,the targeted high school classes will decrease their off-task behavior.

As a result of motivational strategies being implemented during the period of January 2001 to May 2001, the targeted high school classes will increase their achievement.

Process Statements

In order to accomplish the project objectives, the following processes are necessary:

1. Create application problems that relate to the students' lives.
2. Create cooperative learning activities.
3. Develop lesson plans using the multiple intelligences.
4. Use discovery learning tasks in the classroom.
5. Implement student-based projects.

Action Plan for the Intervention

I. Week One: Preparing for the intervention

(January 2001)

A. Discuss the action Research Plan

B. Administer the Pre-Student Survey

C. Send home parental information letter and consent forms

D. Observe each targeted group and fill it the Observation Checklist

E. Gather Data from Homework and test grades

II. Weeks 2 – 17: Increase the student's interest. The teachers will vary the curriculum in mathematics to make the material interesting to the students:

(February, 2001 through May, 2001)

A. The teachers will develop application problems to be included in each section that show students the relevance of mathematics to the real – world.

B. The teachers will include one project in each unit that allows to students to make connections with mathematics and their own lives.

III. Weeks 2 – 17: Teachers will vary their methods of instruction. During the intervention the teachers will include a variety of instructional techniques designed to engage the students in learning:

A. The teachers will create activities that include multiple intelligences. The teachers will target the intelligences that are not currently emphasized in mathematics.

B. The teachers we include the use of graphic organizers in their teaching.

C. The teachers will develop lessons that use problem- based learning and inquiry based learning.

D. The teachers will include use cooperative learning in the classroom.

Methods of Assessment

In order to assess the effects of the intervention, teachers will analyze grades to assess any increase in student achievement. Teachers will observe the students to determine if off-task behavior has decreased and student responsibility has increased. Teachers will administer pre- and post student surveys to determine whether students' attitudes towards math have changed.

CHAPTER 4

PROJECT RESULTS

Historical Description of the Intervention

The objective of this project was to improve student motivation in mathematics. The implementation of varied instructional strategies and assessments were used to improve student interest and reduce math anxiety. Cooperative learning and multiple intelligences were used to improve instruction, while projects were used as alternative assessments.

Multiple intelligences were used to reach every student. Kinesthetic learning was increased through the used of hands-on learning. The students used algebra tiles, called "algeblocks" to demonstrate mathematical concepts. A sample algeblock lesson can be found in Appendix C. The graphing calculator was incorporated to allow for visualization. Calculator-based laboratories (C.B.L) were used for both kinesthetic and visual learning. Sample calculator and C.B.L lessons can be found in Appendix C.

Cooperative learning was also incorporated in the classroom. Students used the expert jigsaw to learn new materials. They used partners and triads to complete tasks in class. Finally they reviewed topics in groups of four using activities such as Spencer Kagen's "numbered heads together" and Stadt's "Teams, Games, Tournaments." Sample cooperative learning lessons can be found in Appendix C.

In addition to changing the method of instruction, alternative assessments were also implemented. Students were assigned projects to improve their interest in mathematics. The assignments focused on the application of the skills used in mathematics. The projects allowed students to see how the content in math class could be used in the real world. Sample projects can be found in Appendix D.

Presentation and Analysis of Results

In order to assess the effects of the intervention student surveys and observation checklists were readministered to the students. Semester grades and homework grades were also analyzed.

The teacher researchers developed a student survey to record the interest level in mathematics (Appendix A). A summary of the results for teacher A is shown in Table 13.

Table 13
Number of Responses for the Math Interest Survey for Teacher A

Question	*Number of responses for strongly agree*	*Number of responses for agree*	*Number of responses for not sure*	*Number of responses for disagree*	*Number of responses for strongly disagree*
Do you find math interesting	3	8	7	4	3
Do you find math challenging	9	8	6	2	0
Do you think you will use math in the future	11	7	5	0	2
Do you use math in your every day life	7	7	8	2	1
Does math relate to your life	4	6	8	4	3

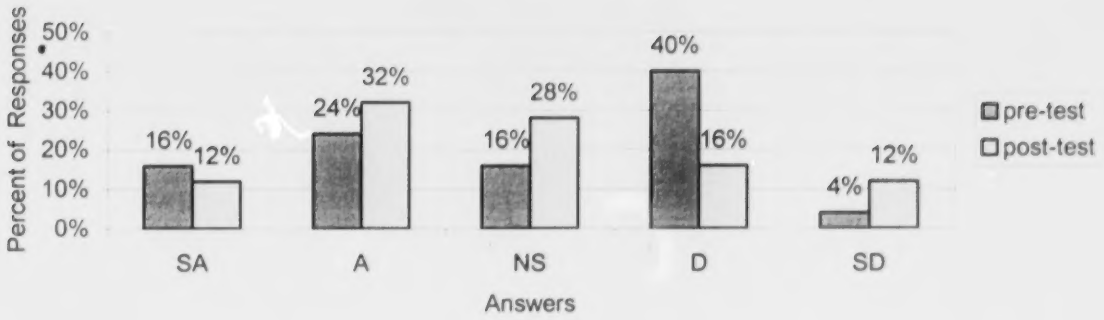

Figure 33. Responses to Question 1: "Do you find math interesting?"

When asked whether they found math interesting, students post-test responses differed from earlier discussions. The number of students who disagreed with the statement decreased during the intervention. Most of the students who changed their opinion were unsure whether they found math interesting. The teacher researchers realize that more work needs to be done in order to help the students find math interesting.

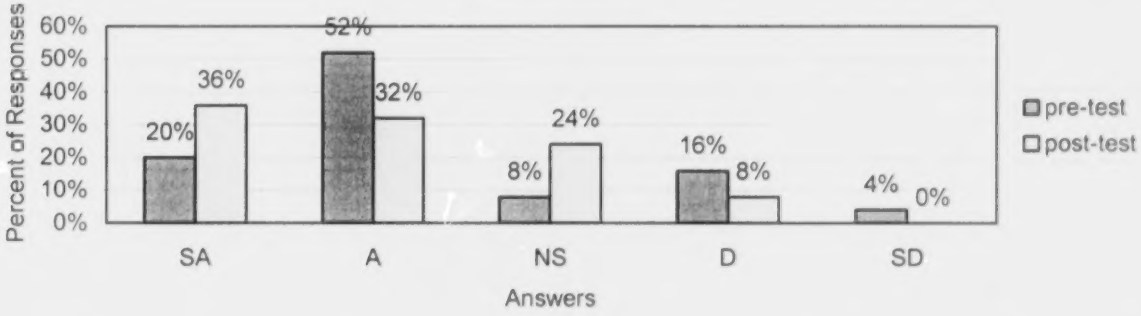

Figure 34. Responses to Question 2: "Do you find math challenging?"

After the intervention, the greatest change in the data was that more students were unsure if they found math challenging. Fewer students disagreed with the statement while more students strongly agreed. The teacher researchers think that this change could be due to the topics that were presented during the intervention. The second semester of Algebra 1 tends to include topics that more difficult for the students to understand.

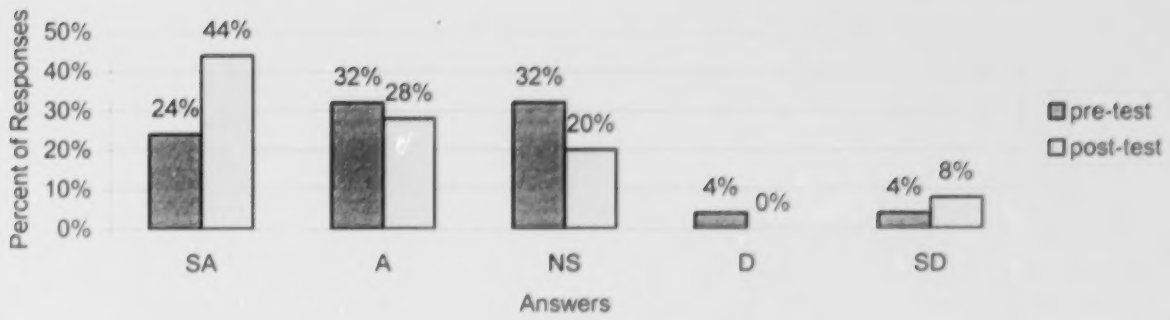

Figure 35. Responses to Question 3: "Do you think you will use math in the future?"

More students strongly agreed with this statement after the intervention. The number of students who were unsure if they would use math in the future decreased. The only concern that the teacher researchers had was that the students who earlier disagreed now strongly disagreed with the statement.

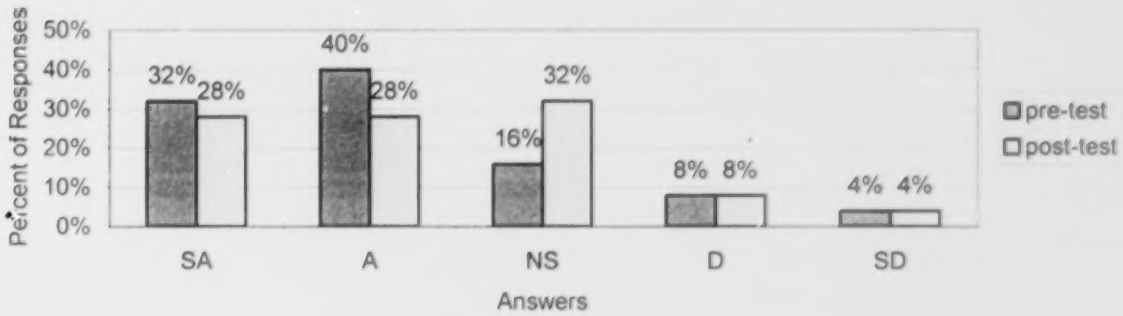

Figure 36. Responses to Question 4: "Do you use math in your every day life?"

In looking at the post-test data, the only change was that some students who agreed or strongly agreed were now unsure if they use math every day. The number of students who were unsure doubled during the intervention.

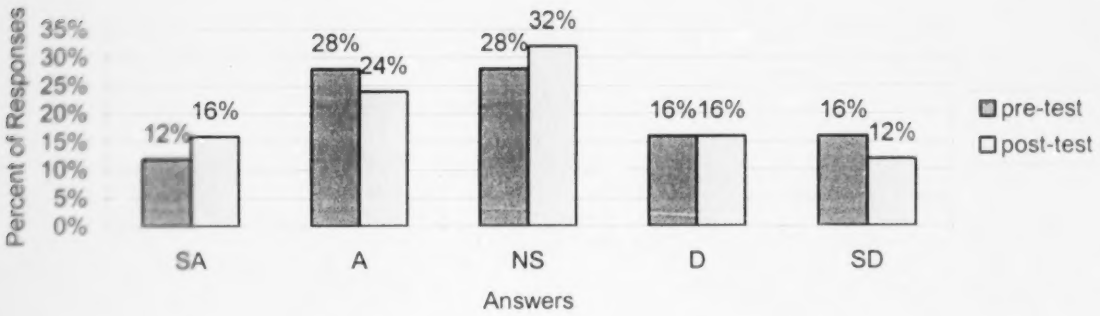

Figure 37. Responses to Question 5: "Does math relate to your life?"

The responses to question 5 were similar to those in question 4. The only significant change was that the number of students who were unsure increased. The teacher researchers realize that the intervention may have failed in helping the students realize how math related to their lives.

Table 14
Number of Responses for the Math Interest Survey for Teacher B

Question	*Number of responses for strongly agree*	*Number of responses for agree*	*Number of responses for not sure*	*Number of responses for disagree*	*Number of responses for strongly disagree*
Do you find math interesting	1	6	7	4	2
Do you find math challenging	8	10	2	0	0
Do you think you will use math in the future	6	11	3	0	0
Do you use math in your every day life	7	6	4	2	1
Does math relate to your life	3	3	6	6	2

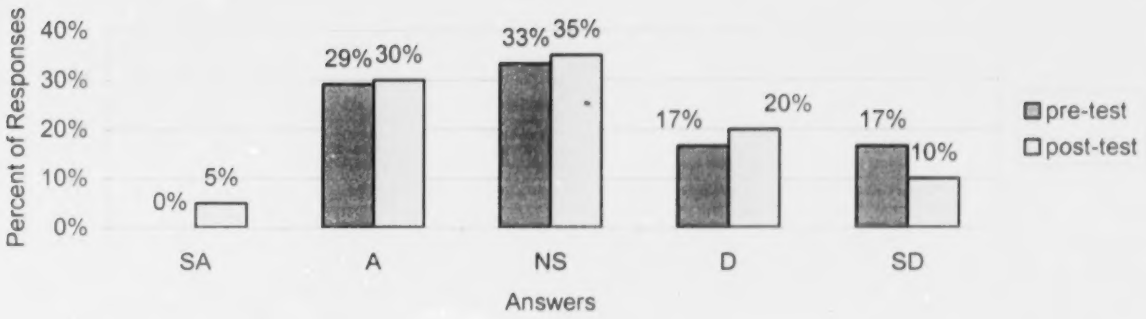

Figure 38. Responses to Question 1: "Do you find math interesting?"

Overall, there was a slight increase in the number of students who agreed that they found math interesting. Again, like in the responses from Teacher A's students, there was a slight increase in students who were unsure of their interest in math.

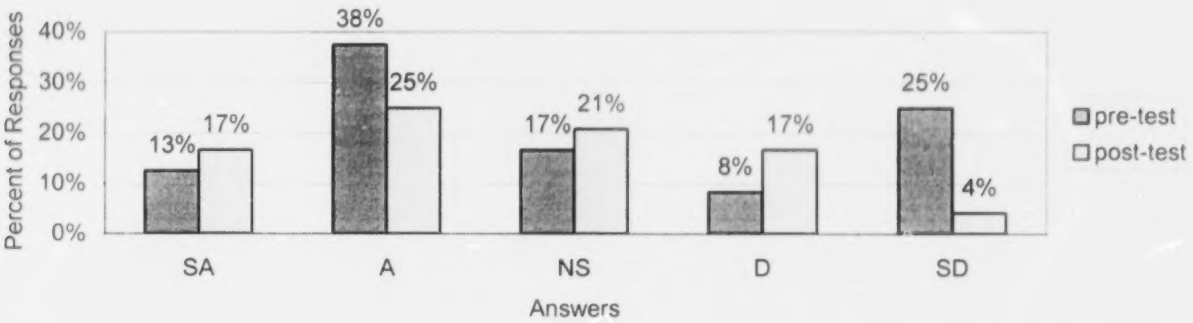

Figure 39. Responses to Question 2: "Do you find math Challenging?"

In looking at the results from the post-test, no students disagreed with the statement "Do you find math challenging?" The teacher researchers are concerned because 90% of the students still find math challenging even after an intervention that was designed to help students realize that math was something that they could do.

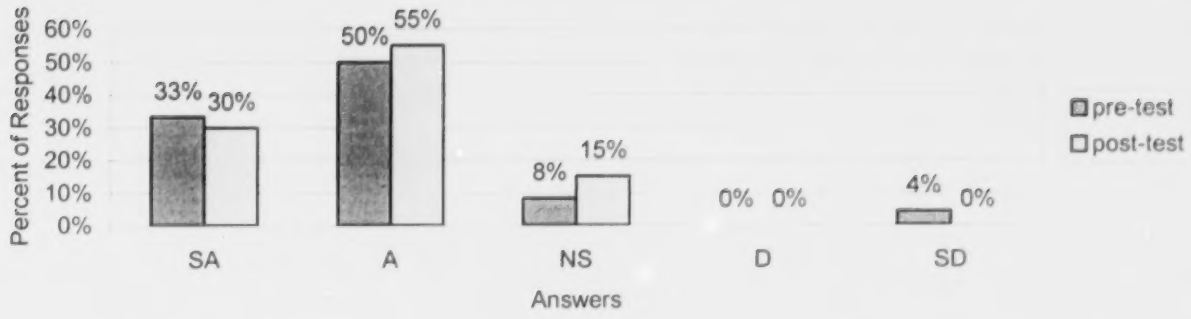

Figure 40. Responses to Question 3: "Do you think you will use math in the future?"

There was not much change in the data for this question from the pre-test to the post-test. No students disagreed about using math in the future, while there was only a slight increase in those students who were unsure.

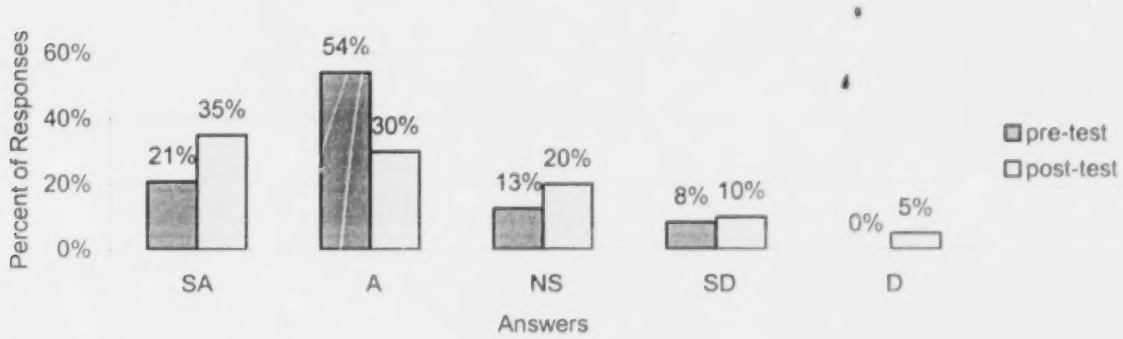

Figure 41. Responses to Question 4: "Do you use math in your every day life?"

In analyzing the post-test results, there was a slight increase in students who disagreed or were unsure if they used math every day. More students strongly agreed that they use math every day.

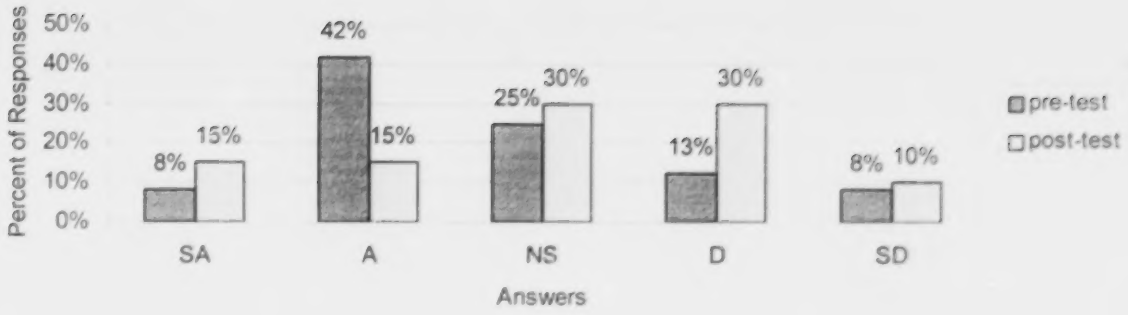

Figure 42. Responses to Question 5: "Does math relate to your life?"

In responding the question 5, there was a significant increase in those students who disagreed with the statement. This concerns the teacher researchers because part of the intervention was to implement more real-world examples and application problems to help students see how they use math in many aspects of their lives.

The teacher researchers also gave the students a post-test to determine their level of math anxiety. (Appendix B) The results of the survey are shown below.

Table 15
Number of Responses for the Math Anxiety Survey for Teacher A

Question	*Number of responses for strongly agree*	*Number of responses for agree*	*Number of responses for not sure*	*Number of responses for disagree*	*Number of responses for strongly disagree*
I would not like to take more math classes	6	1	6	6	6
I worry about my ability to solve math problems	5	6	4	5	5
I get uptight during math tests	5	11	2	5	2
I get a sinking feeling when I try to do math problems	3	4	5	8	5
My mind goes blank and I am unable to think clearly when doing my math	3	6	5	6	5
Mathematics makes me feel uncomfortable and nervous	5	3	4	7	6
Mathematics makes me feel uneasy and confused	5	7	3	7	3

Figure 43. Responses to Question 1: "I would not like to take more math classes"

The number of students who disagreed with this statement increased after the intervention. This data is encouraging to the teacher researchers because students need to take more math classes to get into college and to be successful. If students are willing to take more math classes, they will be able to continue to see how important math is in their lives.

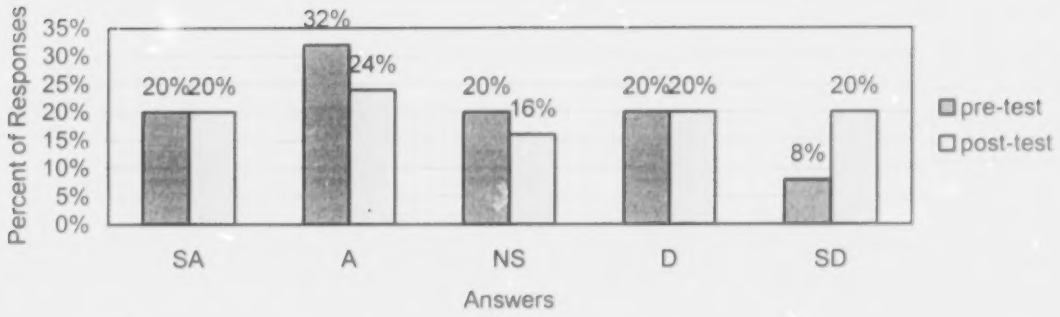

Figure 44. Responses to Question 2: "I worry about my ability to solve math problems"

When asked after the intervention if they still worry about their math ability, more students disagreed than at the beginning of the study. The majority of the students still worry about their ability or are unsure, but the intervention seemed to reach some of the students.

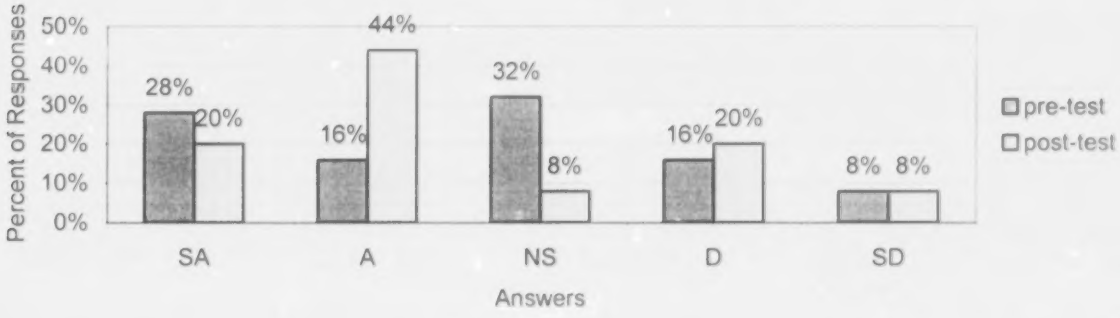

Figure 45. Responses to Question 3: "I get uptight during math tests"

There was a huge increase in the number of students who agreed that they get uptight during math tests. This concerns the teacher researchers; however, the data shows that after the intervention most students either agreed or disagreed. The number of students who were unsure decreased significantly. This helps the teacher researchers continue to explore why students get uptight and what strategies they can implement to help students relax during tests.

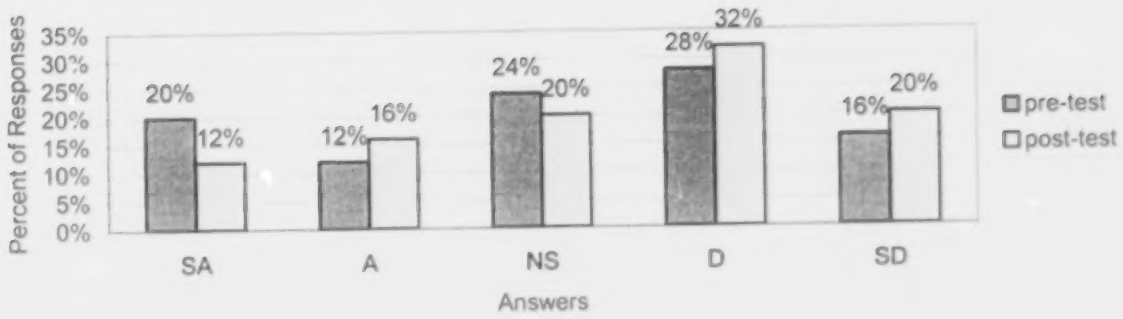

Figure 46. Responses to Question 4: " I get a sinking feeling when I try to do math problems"

The number of students who disagreed with the statement "I get a sinking feeling when I try to do math problems" increased after the intervention. There are still a number of students who agree or are unsure, but it is obvious that some parts of the intervention helped the students to feel more confident in their math ability.

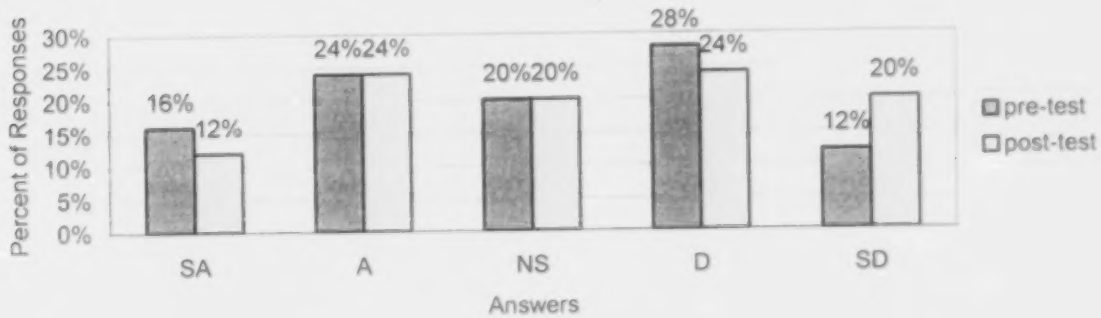

Figure 47. Responses to Question 5: "My mind goes blank and I am unable to think clearly when I am doing my math"

In looking at the results from the post-test, there was very little change in the student responses. The only significant change was that more students strongly disagreed with the statement.

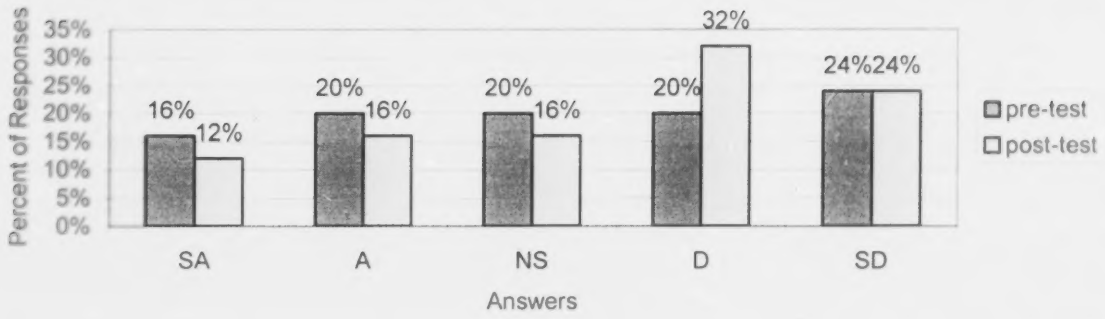

Figure 48. Responses to Question 6: "Mathematics makes me feel uncomfortable and nervous"

More students disagreed with the statement "Mathematics make me feel uncomfortable and nervous" after the intervention. This encourages the teacher researchers to continue to implement lessons that involve the students such as cooperative learning and continue to teach to the eight multiple intelligences.

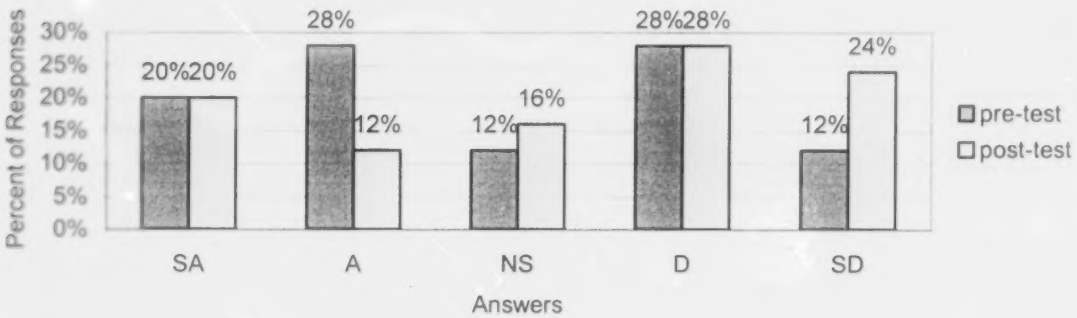

Figure 49. Responses to Question 7: "Mathematics makes me feel uneasy and confused"

In looking at the results of the post-test, more students were unsure or strongly disagreed that math makes them feel uneasy or confused. Surprisingly, the number of students who strongly agreed or disagreed stayed exactly the same. The intervention affected those students who felt strongly about how math makes them feel.

Table 16
Number of Responses for the Math Anxiety Survey for Teacher B.

Question	*Number of responses for strongly agree*	*Number of responses for agree*	*Number of responses for not sure*	*Number of responses for disagree*	*Number of response for strongly disagree*
I would not like to take more math classes	6	4	3	6	1
I worry about my ability to solve math problems	4	6	5	4	1
I get uptight during math test	4	3	5	5	2
I get a sinking feeling when I try to do math problems	2	2	3	11	2
My mind goes blank and I am unable to think clearly when doing my math	4	3	0	13	0
Mathematics makes me feel uncomfortable and nervous	3	2	3	11	1
Mathematics makes me feel uneasy and confused	4	2	4	9	1

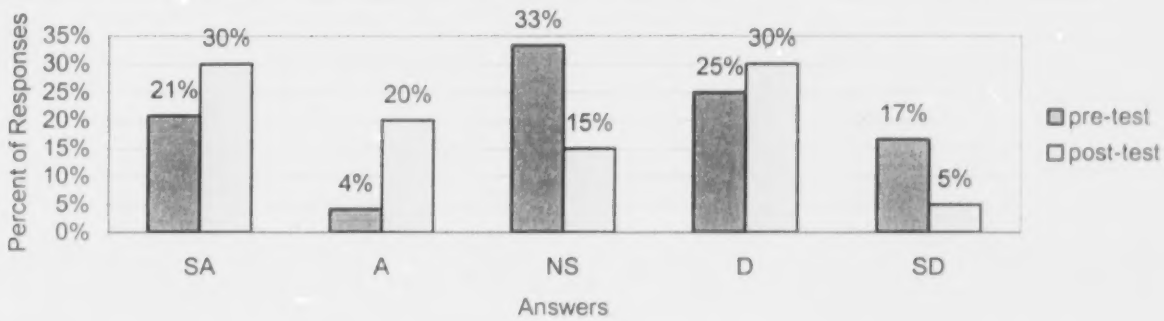

Figure 50. Responses to Question 1: "I would not like to take more math classes"

The teacher researchers were discouraged by the results of question 1. After the intervention, the teacher researchers had hoped that the students would want to take more math classes. In looking at the results from the post-test, more students agreed that they do not want to take more math classes.

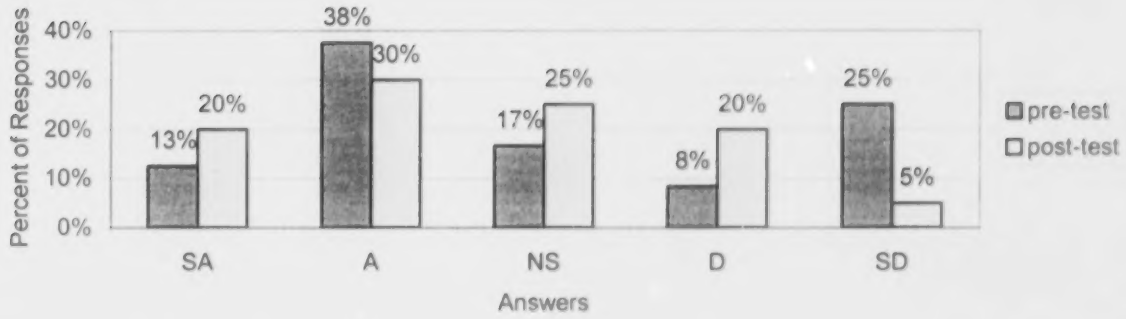

Figure 51. Responses to Question 2: "I worry about my ability to solve math problems"

In looking at the results from the post-test, slightly more students agreed that they worry about their math ability. Slightly fewer students disagreed with the statement while the number of students who were unsure increased.

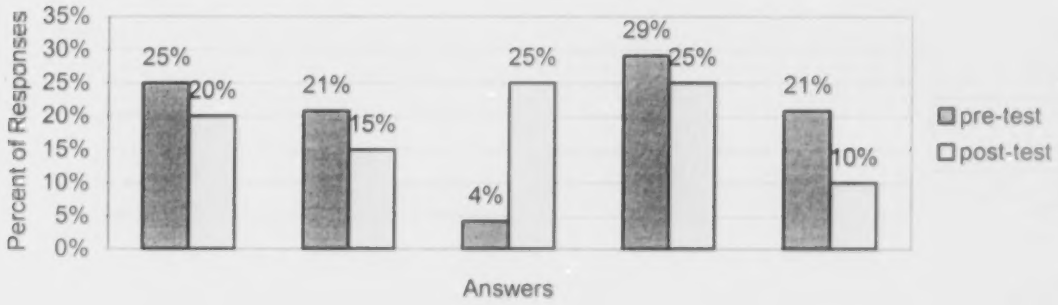

Figure 52. Responses to Question 3: "I get uptight during math tests"

The results for question 3 do not add up to 100% because one student when filling out the post-test survey, left this question blank. When looking at the data, it is encouraging to see that the number of students who agreed that they feel uptight during math tests decreased. However, those students who disagreed also decreased. After the intervention, there are more students who are unsure whether they feel uptight during a math test.

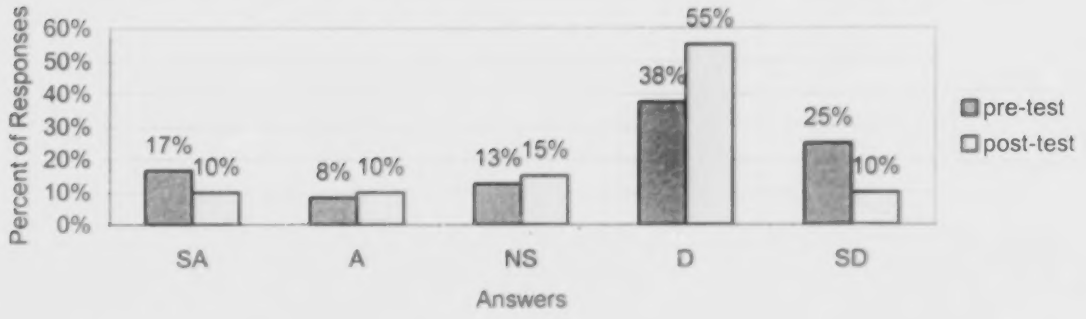

Figure 53. Responses to Question 4: "I get a sinking feeling when I try to do math problems"

The only significant change in the data from the pre-test to the post-test was that students who strongly disagreed now only disagreed with the statement. This is encouraging because the teacher researchers want the students to feel confident when working on math problems.

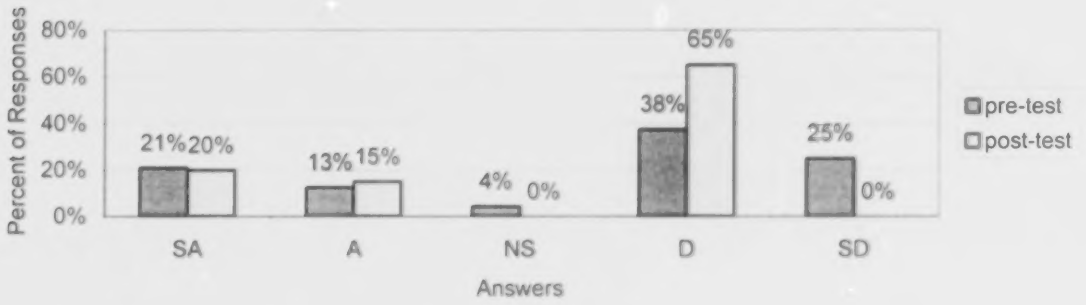

Figure 54. Responses to Question 5: "My mind goes blank and I am unable to think clearly when I am doing my math"

In looking at the post-test results, the only change was that students who were unsure or who strongly disagreed now disagreed with the statement. Almost two-thirds of the students surveyed responded that they can think clearly when working on math problems. This was a focus of the intervention.

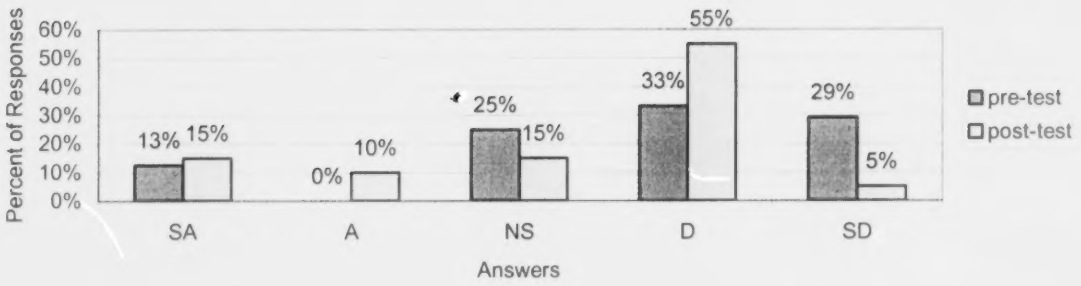

Figure 55. Responses to Question 6: "Mathematics makes mé feel uncomfortable and nervous"

The students who were unsure if math made them nervous decreased during the intervention. However, those students now agree that math make them feel uncomfortable and nervous. This indicates that the teacher researchers have more work to do when it comes to helping the students feel safe and comfortable when working on their math.

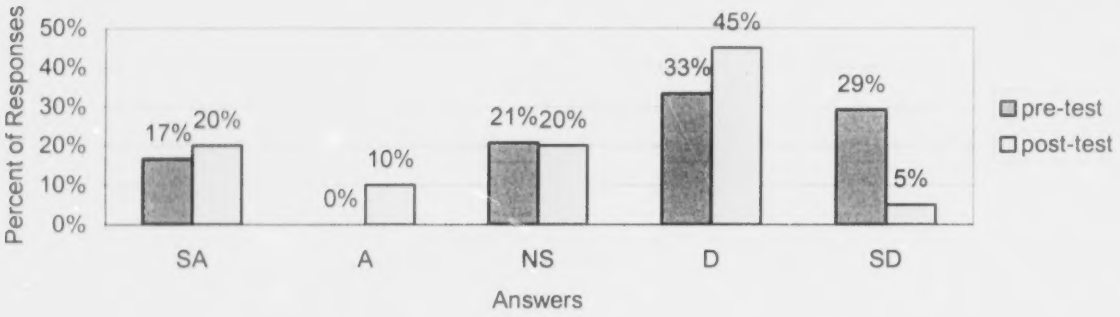

Figure 56. Responses to Question 7: "Mathematics makes me feel uneasy and confused"

The only significant change in the data from the pre-test to the post-test was that students who disagreed at the beginning of the intervention now agreed that math makes them feel uneasy and confused.

The teacher researchers observed the students for a period of two weeks (appendix 3). Students were observed for 10 class periods. The teacher researchers observed both positive and negative behaviors. The following is a list of the behaviors.

Table 17
Number of Occurrences for Negative Behaviors for Teacher A

Behavior	*Number of times*
Side Bar Conversations	27
Day Dreaming	6
Working on other subjects	14

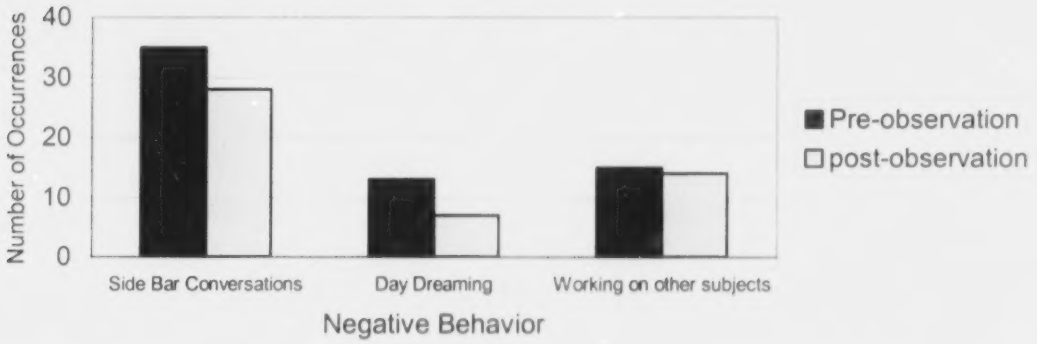

Figure 57. The Number of Occurrences of Negative Behaviors for Teacher A

In looking at the occurrences of negative behaviors in Teacher A's classroom, it should be noted that the number of times that students were observed performing negative behaviors decreased. It was a slight decrease, but the negative behaviors did decrease after the intervention.

Table 18
Number of Occurrences for Positive Behaviors for Teacher A

Behavior	*Number of times*
Ask for help	25
Seek outside tutoring	5
Making up missed assignments	4

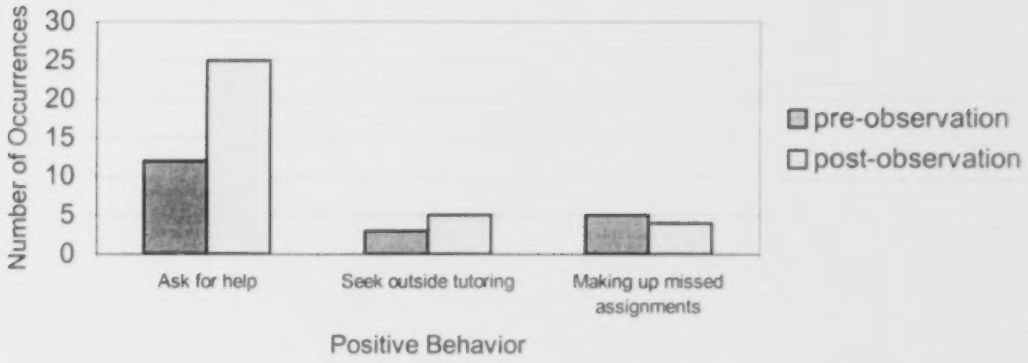

Figure 58. The Number of Occurrences of Positive Behaviors for Teacher A

The number of students asking for help in Teacher A's classroom increased significantly after the intervention was implemented. It can also be seen that students seeking outside tutoring increased, while students making up missing assignments decreased slightly.

Table 19
The Number of Occurrences for Negative Behaviors for Teacher B

Behavior.	*Number of times*
Side Bar Conversations	27
Day Dreaming	15
Working on other subjects	23

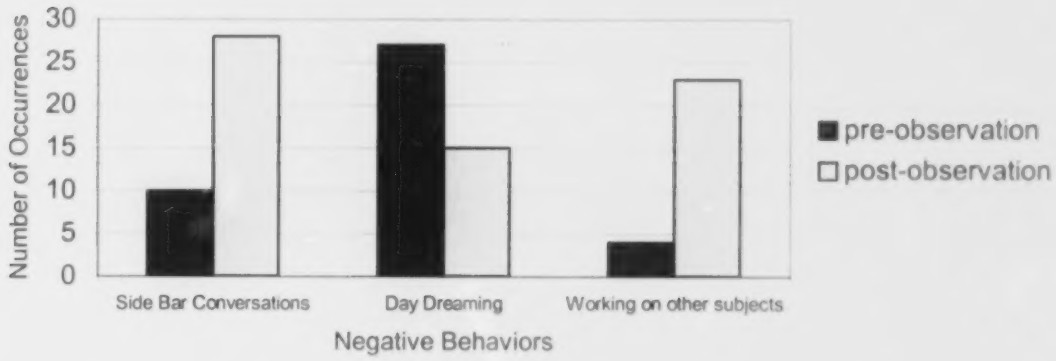

Figure 59. The Number of Occurrences of Negative Behaviors for Teacher B

While looking at Teacher B's observations after the intervention, it is obvious that the students did not reduce the number of negative behaviors that they engaged in. Side bar conversations in this classroom almost tripled from the pre-observation to the post-observation. Similarly, students observed working on other subjects quadrupled. This could be due to the time of the year that the post-observation took place. Students in pre-algebra tend to be very disengaged at the end of the school year.

Table 20
The Number of Occurrences for Positive Behaviors for Teacher B

Behavior	*Number of times*
Ask for help	37
Seek outside tutoring	10
Making up missed assignments	17

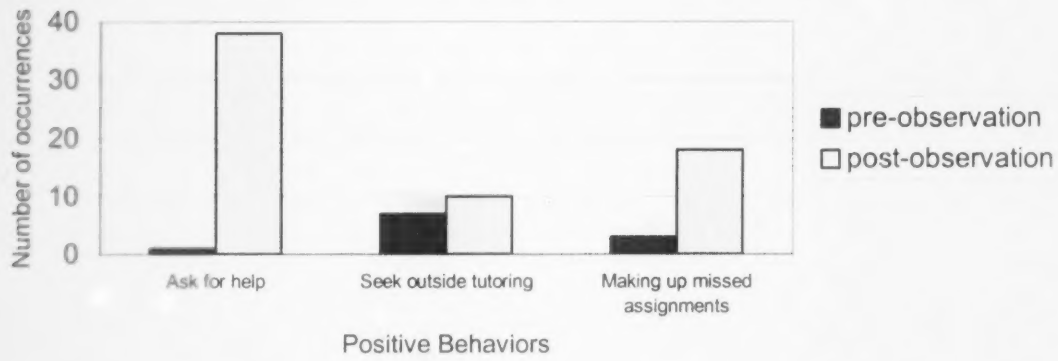

Figure 60. The Number of Occurrences of Positive Behaviors for Teacher B

After the intervention, the positive behaviors in Teacher B's classroom, increased dramatically. Students asking for help increased significantly. This may be due to more time given to the students to complete their homework assignments. They knew what their questions were before they left class and felt comfortable enough to ask the teacher for help. Students making up missing assignments also increased. This may be due the observations being made

towards the end of the school year. Students tend to make up more assignments when they know that they will be getting assigned a grade soon.

Finally the teacher researchers analyzed the student's grades. They first analyzed the students overall grades. Then they looked at homework grades. Homework grades account for 25% of the final grade.

Table 21
Semester 2 grades for Teacher A's students

Grade	*Number of students with this grade*
A	4
B	7
C	5
D	4
F	5

Figure 61. A Comparison Between First Semester and Second Semester Grades for Teacher A

After the intervention, the semester grades for Teacher A improved. More students received A's and C's while less students received D's and F's.

Table 22
Homework grades of Teacher A's students

Grade	*Number of students with this grade*
A	12
B	2
C	3
D	2
F	6

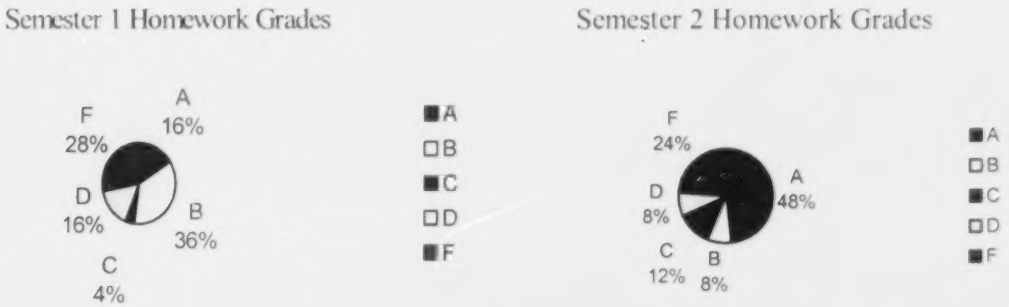

Figure 62. A Comparison Between First Semester and Second Semester Homework Grades for Teacher A

After the intervention, homework completion in Teacher A's classroom increased dramatically. Nearly half of the students turned in their homework on a daily basis. At the time of year that the data was collected, student completion on homework is usually very poor.

Table 23
Semester Grades for Teacher B

Grade	*Number of students with this grade*
A	1
B	7
C	4
D	4
F	8

Figure 63. Shows a Comparison Between First Semester and Second Semester Grades For Teacher B

After the intervention, the number of A's in Teacher B's classroom decreased, but the number of B's increased. Students who received an A first semester, received a B for the second semester. A positive observation of the post data is that the number of F's decreased slightly.

Table 24
Homework Grades for Teacher B

Grade	*Number of students with this grade*
A	9
B	2
C	2
D	1
F	10

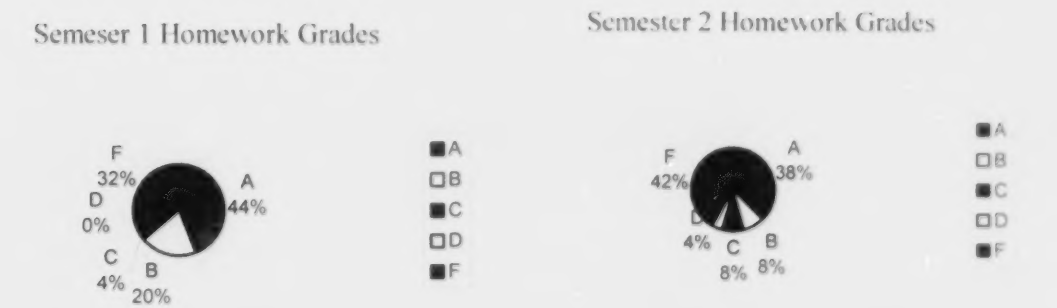

Figure 64. A Comparison Between First Semester and Second Semester Homework Grades for Teacher B

Homework grades of the students in Teacher B's classroom, decreased during the second semester. This is typical for the type of student that was observed in the intervention. Second semester tends to have more difficult topics for the students. Grades usually decrease because of the change in seasons. Students typically do not spend as much time on their homework at the end of the school year.

Conclusions and Recommendations

Based on the presentation and analysis of the data on student attitudes towards mathematics, there was an improvement in the number of positive behaviors exhibited in the classroom. The use of multiple intelligences and relating mathematics to the students' lives helped students to behave more appropriately in the classroom. Although negative behaviors did not decrease as much as the teacher researchers were expecting, the positive behaviors did increase significantly.

Based on the presentation and analysis of the data on student attitudes towards mathematics, there was a slight improvement seen in the responses to the math interest survey and math anxiety survey administered to the students. Overall, there was a slight increase in the number of those students who now feel more comfortable in the mathematics classroom.

The teacher researchers, if given the opportunity to study this issue again, would make one significant change in the study. The teacher researchers would change the time of year that the pre-data and post-data were collected. The pre-data were collected at the start of the second semester. At this time, students are eager to begin a new semester of study. Grades are not cumulative throughout the entire year, so the students have a chance to "start over." With this incentive, student attitudes tend to be more idealistic and positive.

A problem also arose in the time of year that the post-data were collected. The post-data were collected at the end of the second semester in May. Students, especially in the Fundamentals class observed, tend to be very apathetic at that time of the school year. The teacher researchers feel that the data may have been skewed by the time of the pre- and post-data were collected.

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Appendix A

Math Interest Survey

Please rate each of the following questions

	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
1. Do you find math interesting	SA	A	NS	D	SD
2. Do you find math challenging	SA	A	NS	D	SD
3. Do you think that you will use math in the future	SA	A	NS	D	SD
4. Do you use math in your every day life	SA	A	NS	D	SD
5. Does math relate to your life	SA	A	NS	D	SD

Appendix B

Math Anxiety Checklist:

Please rate each of the following questions

	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
1. I would not like to take more math classes	SA	A	NS	D	SD
2. I worry about my ability to solve math problems	SA	A	NS	D	SD
3. I get uptight during math tests	SA	A	NS	D	SD
4. I get a sinking feeling when I try to do math problems	SA	A	NS	D	SD
5. My mind goes blank and I am unable to think clearly when doing my math	SA	A	NS	D	SD
6. Mathematics makes me feel uncomfortable and nervous	SA	A	NS	D	SD
7. Mathematics makes me feel uneasy and confused	SA	A	NS	D	SD

Adapted from Godbey, C. (1997). Mathematics anxiety and the underprepared student. Unpublished Master's Thesis.

Appendix C
Sample Lesson Plans

OBJECTIVE: Add and subtract polynomials using algeblocks

PART I – REVIEW
A) Sketch each algeblock and write its color

UNIT	X	x^2	Y	Y^2	XY
Color					
Sketch					

B) What are zero pairs?

c) How do you move algeblocks form the mat?

d) On your mat model $4x + 3y - 2x - y$
Sketch the mat:

e) Remove any zero pairs
f) Write the resulting expression

g) How did you get that?

h) How many terms are in your first expression?

i) How many different types of like terms are there?

j) Add using algeblocks $3x + 2 - y + 1 - 2x - y - x$

Part II – Adding polynomials
We are going to add $(x^2 + 2x) + (2x^2 - 5x)$
a) put $x^2 + 2x$ on you mat
b) Add $2x^2 - 5x$ on your mat
c) Add like terms – remove all zero pairs. What is your new answer?
d) How do you add polynomials using algeblocks?

EXAMPLES: Add the following using algeblocks

1. $(x^2 - 4x + 10) + (3x^2 - 9x - 11)$
2. $(-4xy - 3x + x^2) + (4x - 2xy + 4x^2)$
3. $(-10 + 2xy + 3y) + (-12 - 2xy + 5x)$

PART III – Subtracting polynomials

1. Model the expression –(x+2)

a) Put x+2 on your mat
b) Because there is a negative in front move each piece to its opposite side
c) What is the result?

EXAMPLES

Simplify each expression

a) $-(2x-4)$
b) $-(2xy - y)$
c) $-(x^2 + 3y^2)$
d) $-(-x + 3)$

2. Model the expression (4x-3) –(2x-5)

a) put 4x-3 on the mat
b) Put 2x - 5 on the mat
c) Since you are subtracting, switch 2x –5 to the opposite sides
d) Combine like terms and remove all the zero pairs
e) What is the result?

EXAMPLES

Subtract each expression

1. $(2x - 10) - (4x - 1)$
2. $(xy - 5x + 3) - (4xy + 2x - 1)$
3. $(x^2 - 3x + 2) - (x^2 + y^2 - 4x)$

SUMMARY:

1) How do you add polynomials using algeblocks?
2) How do you subtract polynomials using algeblocks?
3) How do you think you would add polynomials without using algeblocks?
4) How do you think you would subtract polynomials without using algeblocks

HOMEWORK 11.5 11-14, 23-26, 27-32, 38-41

Objective: explore patterns in factoring using algeblocks

PART I - Introduction

Lets go through the example on page 571 together.

1.

2.

3.

PART II – Review.

Multiply the following using algeblocks- lets do the first one together

1. (x+2) (x-1)

2. (x-2)(x-1)

3. (x+3) (x+1)

PART III - FACTOR ON YOUR OWN

Pattern 1

1. $X^2 + 4X + 3$

2. $Y + 6Y + 8$

3. $Y^2 + 9Y + 8$

4. What pattern do you notice in numbers 1- 3

Pattern 2

Factor the following- (hint – Use all four quadrants to form the rectangles)

5. $X^2 - 2x + 1$

6. $X^2 - 7x + 6$

7. $Y^2 - 3y + 2$

8. What pattern do you notice in numbers 5-7

Pattern 3

Factor the following (hint – you may need to use zero pairs to complete the rectangles)

9. $y^2 + y - 2$

10. $x^2 + 2x - 3$

11. $y^2 + 2y - 8$

12. What pattern do you notice in numbers 9-11

Pattern 4

Factor the following

13. $x^2 - x - 6$

14. $y^2 - 4y - 5$

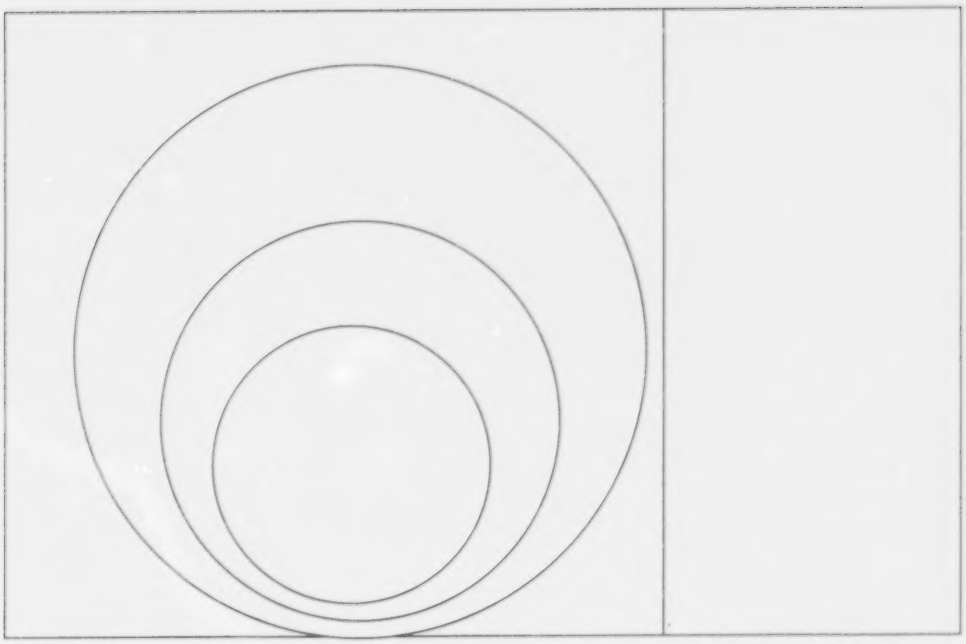
15. $x^2 - 3x - 10$

16. What patterns do you notice in 13-15?

SUMMARY

1. Compare and contrast patterns 1- 4. List at lest two comparisons and three contrasts
2. List at least one thing you can conclude about the polynomials and their factors for each pattern.
3. How do you think you could factor polynomials without algeblocks?

HOMEWORK 12.1 38-44



DEFINITIONS AND EXAMPLES

Whole-

Real-

Rational-

Integer-

Irrational-

DETERMINING WHICH NUMBER IS GREATER

ABSOLUTE VALUE

In each box, write down what the algeblock symbolizes

Green cube	Yellow rectangle	Yellow square	Yellow cube	Orange rectangle	Orange square	Light orange rectangle

Represent each expression using algeblocks. Draw the representation in the table:

1) -5	2) x + 7	3) 3x -5	4) -2y + 4
+	+	+	+
-	-	-	-

What is a zero pair?

We are now going to add using algeblocks. Add -4 + 10

a) Put -4 on the mat
b) Put 10 on the mat.
c) Remove all "zero pairs"
d) Write down your answer.

Part IV - adding numbers with the same sign

1. Add the following using algeblocks

a) -4 + -2 b) -3 + -10
c) 10+5 d)-14 + -1
e) 7 + 2 f) - 13 + - 3

2. What do you think the rule is for adding numbers with the same sign?

Part V - adding numbers with different signs

1. Add the following using algeblocks

a) -4 + 2 b) -3 + 10
c) 10+ -5 d) -14 + 1
e) 7 + -2 f) 6 + -5

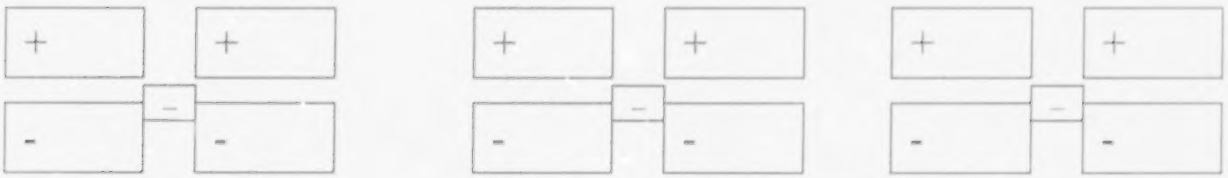
2. What do you think the rule is for adding numbers with different signs?

PART I - together

1) x + 1 = 12
   a) Set up the algeblocks
   b) What do you need to do to get x by itself?

   c) Add -1 to each side
   d) Write your answer

2) Solve each of the steps by yourself: **x - 4 = 10**
Draw a picture of your steps in the space below:



PART II - SOLVE USING ALGEBLOCKS

1) x + 4 = 12

2) x - 3 = 2

3) x + 11 = 2

4) x - 4 = 10

5) y + 7 = -7

6) y - -2 = -3

7) x - 4 = -8

8) x - 2 = 12

9) x + 2 = 12

10) x - 7 = - 21

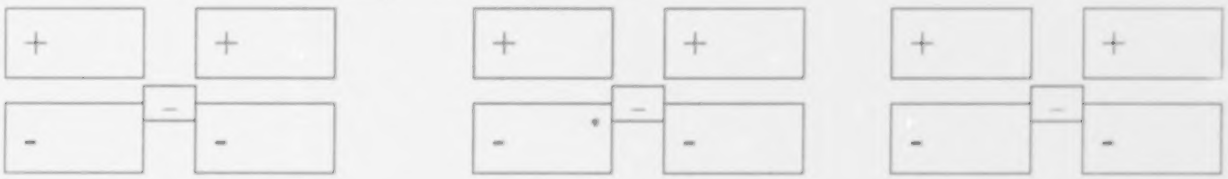
PART I - together

1) 4x = 12

a) Set up the algeblocks
b) What do you need to do to get x by itself?

c) Divide the figure into four equal piles
d) Write your answer

2) Solve each of the steps by yourself: **2x = 10**
Draw a picture of your steps in the space below:



PART II - SOLVE USING ALGEBLOCKS

1) 2x = 8

2) 3x = -9

3) 4x = -8

4) 6x = 12

5) -7y = -7

6) -2y = 10

SUMMARY (answer on a separate sheet of paper)

1) How do you think you solve equations using adding and subtracting?
2) How do you think you solve equations using multiplying and dividing?

PART 1

1. Determine who is person "A" and who is person "B".
2. Person A write down a true inequality. Record it on sheet 2
3. People B write down a true inequality. Record it on sheet 2
4. Pick a positive integer. Record it on sheet 2
5. Pick a negative integer. Record it on sheet 2

PART 2 (to be used with part 3)

1. Person A does the operation below (answer in column a)
2. Determine if the inequality stays true(answer in column b)
3. Person B does the operation below(answer in column c)
4. Determine if the inequality stays true(answer in column d)
5. Do you think the inequality will always stay true(answer in column e)

PART 3 (to be used with part 2)

1. add the positive integer to both sides
2. add the negative integer to both sides
3. subtract the positive integer from both sides
4. subtract the negative integer from both sides
5. multiply both sides by the positive integer
6. multiply both sides by the negative integer
7. divide both sides by the positive integer
8. divide both sides by the negative integer

SUMMARY:

1. What operations resulted in an untrue inequality?

2. How could you make the untrue inequalities true?

3. What suggestions do you have to make the operations in number1 result in a true inequality?

names _____

_____

PERSON "A" INEQUALITY
PERSON "B" INEQUALITY
NEGATIVE VARIABLE
POSITIVIE VARIABLE

	A	*B*	*C*	*D*	*F*
	Your Inequality	***True?***	***Other Inequality***	***True?***	***Always true?***
1					
2					
3					
4					
5					
6					
7					
8					

Appendix D
Sample Projects

The Numbers Game

Objective: Students will be aware of how numbers are a part of their lives in ways other than the obvious tasks of computation and analysis.

Situation: You and your partner are to find the meanings of the "number" phrases listed on the worksheet. Try to find other number phrases that are not listed.

Possible Strategies:

1- Skim the list and write the meanings of any phrases you know.

2- Write any other number phrases (not on the list) that you know.

3- Consult dictionaries or math reference books to find the meanings of the phrases.

4- Ask your parents if they know the meanings.

To Be Submitted: number phrases worksheet

Due Date:_____

(all projects adapted from Hands-On Math Projects with Real-Life Applications by Gary Robert Muschla and Judith A. Muschla)

Number Phrases Worksheet **Name:**_____

Write the meaning of each phrase below. On the second line, write the source in which you found the phrase.

1. **One-liner** _____

_____

2. **In two shakes of a lamb's tail** _____

_____

3. **Three-dog night** _____

_____

4. **On all fours** _____

_____

5. **Take five** _____

_____

6. **Six of one and a half dozen of the other** _____

_____

7. **Seven seas** _____

_____

8. **Eight-hour day** _____

_____

9. **On cloud nine** _____

_____

10. **Top 10** _____

_____

(all projects adapted from Hands-On Math Projects with Real-Life Applications by Gary Robert Muschla and Judith A. Muschla)

11. **Eleventh Hour** _____

_____

12. **Twelvemonth** _____

_____

13. **Catch-22** _____

_____

14. **Twenty-three skidoo** _____

_____

15. **Twenty-four hour** _____

_____

16. **Forty winks** _____

_____

17. **Fifty-fifty** _____

_____

18. **Eighty-eight** _____

_____

19. **Ninety-nine times out of a hundred** _____

_____

20. **Hundred and one** _____

_____

21. **One hundred percent** _____

_____

(all projects adapted from Hands-On Math Projects with Real-Life Applications by Gary Robert Muschla and Judith A. Muschla)

22. **Thousand and one** _____

_____

23. **Sixty-four thousand dollar question** _____

_____

24. **Feel like a million** _____

_____

25. **A million to one** _____

_____

(all projects adapted from Hands-On Math Projects with Real-Life Applications by Gary Robert Muschla and Judith A. Muschla)

Making a Math Poster

Objective: Students will create a math poster for the classroom.

Situation: You and your partner are to design a math poster to be displayed in your math classroom. You are to pick a subject that we have covered during this semester (Chapters 5, 6 or 7).

Possible Strategies:

1- Study examples of posters. Determine what you feel makes some posters more effective than others.

2- Review the tips given about what makes a poster effective.

3- Look through your book to find a topic that you would like to display.

Some things to consider:

- Make sure your topic is not too broad.
- If you think your topic may be too broad, narrow it down.
- Try to make your poster unified and balanced
- Try to include a clever illustration. You can find a good illustration in a magazine, a catalog or on the computer.
- Be neat!

Tips:

- **Selling Point:** The purpose of a poster is to announce something or sell something.
- **Benefits:** The poster tells readers what they have to gain by following the poster's advice or suggestions, or at least offers important information.
- **Gaining Attention:** Every poster attempts to gain and hold attention.
- **Simplicity:** The best posters are simple and easy to read. Too many colors, pictures, or fancy lettering will detract from the poster's message.
- **Unity:** Everything in a poster should work toward its purpose.
- **Balance:** No part of the poster should overpower another.
- **Workmanship:** This is the overall quality of the poster, including lettering, coloring, pictures, and message. Quality workmanship results in outstanding posters.

(all projects adapted from Hands-On Math Projects with Real-Life Applications by Gary Robert Muschla and Judith A. Muschla)

The Geometry and the Art of Architecture

Objective: Students will relate their study of Geometry to architecture by selecting a building or structure and identifying its geometric shapes and properties.

Situation: You and your partner will make a poster of a building or other structure, and identify various geometric shapes and properties. You will also write a brief description of your building or structure.

Possible Strategies:

1- List any famous buildings or structures that you and your partner know.

2- Choose a building or structure that is part of a topic that interests you.

Special Considerations:

- You'll need to conduct research to find a picture or photograph of the building or structure you have chosen. Check books on buildings and architecture, encyclopedias, atlases, history books, geography books, magazines and similar sources.

- In examining your building or structure, try to find as many examples of geometry as possible. You want to look for examples of the following:
  - Type of angles
  - Regular Polygons
  - Circles
  - Three-dimensional shapes
  - Parallel and perpendicular lines
  - Symmetry, including reflections, rotations, and translations

- Draw your building or structure on a poster as accurately as you can. Title your drawing and neatly label the examples of geometry.

- When you write your description, be sure to include the history or background of your building or structure, as well as a summary of what it represents. Type up your description (it should be at least two paragraphs) and staple it to the bottom of your poster.
  Be sure to answer the following questions in your description:
  - Who designed the building or structure?
  - What are its dimensions?
  - Where is it located?
  - When was it constructed?
  - Why was it constructed?
  - Is it used today? If so, how?

Due Date:_____

(all projects adapted from Hands-On Math Projects with Real-Life Applications by Gary Robert Muschla and Judith A. Muschla)